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THE

FOSSILS OF THE SOUTH DOWNS,

&c.

98

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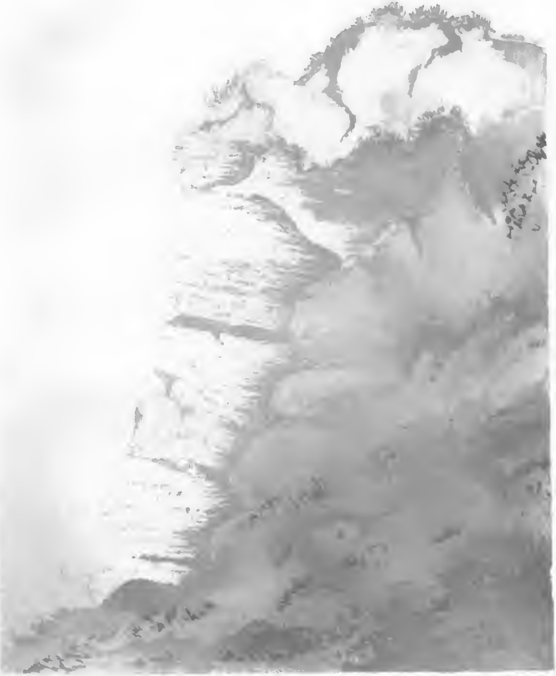

STRATA AT CASTLE HILL, NEAR NEWHAVEN.

THE

FOSSILS OF THE SOUTH DOWNS;

OR

ILLUSTRATIONS

OF THE

GEOLOGY OF SUSSEX.

BY GIDEON MANTELL, F. L. S.

FELLOW OF THE ROYAL COLLEGE OF SURGEONS, MEMBER OF THE GEOLOGICAL SOCIETY, &c.

THE ENGRAVINGS EXECUTED BY

MRS. MANTELL,

FROM DRAWINGS BY THE AUTHOR.

> " Dès l'instant que je me suis consacré à la médicine, persuadé que la connoissance des corps naturels, source unique de la matière médicale, est indispensable au médecin, qui en tire tous ses secours, et qui y retrouve tout ce qui dans l'ordre physique peut faire le bonheur, ou causer le malheur des hommes ; je n'ai cessé d'y employer les momens, dont les occupations nombreuses attachées à notre état, m'ont laissé la disposition."
>
> *Oryctographie de Bruxelles, par F. X. Burtin.*

> " The mind which has been directed to the investigation of a favourite science, is unwilling to persuade itself, that its powers, however feeble, have been concentrated in vain; since the faintest rays, when collected into a focus, produce some degree of illumination."
>
> *Dr. Armstrong.*

LONDON:
LUPTON RELFE, 13, CORNHILL.

1822.

TO

DAVIES GILBERT, ESQ., M.P. F.R.S. and L.S.

PRESIDENT OF THE GEOLOGICAL SOCIETY OF CORNWALL, &c. &c. &c.

THIS VOLUME IS INSCRIBED

AS A

TRIBUTE OF THE HIGHEST RESPECT TO HIS TALENTS,

AND

OF GRATITUDE FOR HIS FRIENDSHIP.

Castle Place, Lewes,
May 1, 1822.

PREFACE.

The flattering manner in which the Prospectus of the present volume has been received, and the condescension of His Majesty, who has been graciously pleased to honour it with his august patronage, are circumstances which demand my most grateful acknowledgments, and are the more gratifying to my feelings, as they were wholly unexpected.

It is, however, with much diffidence that I appear before the public in the characters of an artist and an author, conscious as I am, that my humble talents can offer but few pretensions to its favour, or indulgence.

Having at an early period in life, imbibed a predilection for the study of natural history, and subsequently been educated in a profession intimately connected with that science, upon fixing my residence at Lewes, I resolved to devote my leisure moments to the investigation of the "Organic remains of a former world;" a study replete with interest and instruction.

The fossils of Sussex had not then excited attention, and this consideration induced me to select them for the more immediate objects of examination; since in a district previously unexplored by the geologist, there was reason to hope, that some interesting and useful information might be obtained:—how far that expectation has been realized, it is for the reader to determine.

In the prosecution of these researches, the physical structure of the country necessarily came under consideration, and the enquiry assumed a new and more important character. The extraneous fossils were no longer regarded merely as subjects of natural history, but as memorials of revolutions which have swept over the face of the earth, in ages antecedent to all human record and tradition.

The following pages contain the result of my labours. They have been composed under circumstances particularly unfavourable to literary pursuits; and such as those only can duly appreciate, who are aware of the numerous and anxious duties, which a country practitioner is called upon to perform. Few indeed have been the moments dedicated to this work, that have not been snatched from the hours of repose, after active and laborious exertion during the day.

Another formidable obstacle has arisen from local situation, which has prevented access to a comprehensive library, and thus deprived me of the important aid to be derived from an unlimited reference to the works of others.

If I allude to these circumstances, it is not from the unmanly wish of shrinking from candid and honourable criticism; but neither prudence nor policy require me to suppress any thing that can be offered in extenuation of the imperfections of this volume.

As the engravings are the first performances of a lady but little skilled in the art, I am most anxious to claim for them every indulgence. I am well aware that the partiality of a husband may render me insensible to their defects; but although they may be destitute of that neatness and uniformity, which distinguish the works of the professed artist, they will not, I trust, be found deficient in the more essential requisite of correctness.

It was originally intended to have restricted these researches to the South-eastern division of Sussex; but they have insensibly extended over a wider field, and now, in a great measure, comprehend the geological phenomena of the whole county. That the sketch is incomplete, I most readily acknowledge; nor am I desirous that it should be considered in any other light than as a collection of facts illustrative of the physical structure of the district.

The Essay on the Mosaic account of the Creation, was communicated to me by a clergyman of the established church, soon after the announcement of the present work for publication. The vast importance of the subject, and the ability and temper with which it is discussed, render any apology for its insertion unnecessary. I will not, however, conceal the gratification it affords me, that the excellent author has chosen these humble pages as the medium of its appearance before the public; since the arguments he has adduced must effectually silence the idle clamours that have been raised against geological speculations, from their supposed tendency to scepticism.

I now arrive at the most gratifying part of my labours; that of returning my warmest thanks for the kind and able assistance which my scientific friends and correspondents have so liberally afforded me: but there are others to whom a deeper debt of gratitude is due; who have taken a lively interest in the success and reputation of the author, and have patronized his undertaking with a zeal and liberality far exceeding his most sanguine expectations[*]. To these excellent and much valued friends, I am indeed under infinite obligations; and whatever may be the fate of this volume, the consciousness that it has procured me the acquaintance and esteem of characters as eminent in science, as they are estimable in private life, will more than compensate for any pains and anxiety it may have occasioned.

Castle Place, Lewes,
May 1st, 1822.

---

[*] Among these, Mrs. Durrant, and William Baldock, Esq. of Malling House, near Lewes, merit my warmest acknowledgments.

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ERRATA.

The distance of the author from the press, and the hasty manner in which he has been compelled to inspect the proofs, have occasioned mistakes, which a more deliberate revision of the text would have prevented. Errors that are merely typographical are too obvious to require notice; those which affect the sense are here subjoined.

Page 15, line 28, for "*first*," read *Arun*.
—— 22, —— 19, — "*Bracksley*," read *Bexley*.
—— 23, —— 18, — "*west*," read *coast*.
—— 27, —— 7, — "*insulated*," read *insinuated*.
—— 30, —— 3, — "*these*," read *there*.
—— 38, —— 29, — "*they*," read *the strata*.
—— 82, —— 16, — "*aucula pectinat*," read *nucula pectinata*.
—— 101, —— 5, — "*the marl*," read *since the marl*.
—— 106, —— 26, — "*spinous obtuse*," read *obtuse spinous*.
—— 108, —— 8, — "*closel*," read *closely*.
—— 112, —— 11, — "*have*," read *has*.
—— 141, —— 31, — "*Brongniarti*," read *Hoperi*.
—— 164, —— 29, — "*spongus corpus*," read *spongus.—corpus*
—— 172, —— 9, — "*a state*," read *the state*.
—— 174, —— 18, — "*been closed*," read *be enclosed*.
—— 178, —— 15, — "*et d'eponge*." read *d'eponge*.
—— 253, —— 20, — "*circumstances similar*," read *similar circumstances*.

In the Wood cut, p. 175, the letters of reference *b. c.* are misplaced: the former should stand in the place of the latter.

⁂ Since this Volume was committed to the press, the public have been favoured with an elegant and highly interesting work on the *Trilobites* and fossil *Crustacea*, by M. M. Brongniart and Desmarest, in which allusion is made to the specimens from the Sussex chalk; and it is highly gratifying to me to find that the opinions of these eminent naturalists coincide with those I have advanced in the following pages. On the species which I have named Astacus *Leachii*, (see p. 221.) M. Desmarest offers the following remarks:—" Le crustacé auquel appartenaient ces pinces, avait la forme ordinaire des Macroures, et ne présentait, sur les pièces que nous avons vues d'autres caractères extérieurs que ceux qui consistaient dans la présence de trois forts tubercules sur chaque côté de la carapace, qui était d'ailleurs très-rugueuse. Il était un peu plus grand que l'Ecrevisse fluviatile."—*Crust. Foss.* p. 137. The fossil crustacea of the Blue marl, (see p. 97.) this celebrated philosopher considers, with Dr. Leach, as being nearly related to the genus Corystes, (*Crust. Foss.* p. 125). The SCYLLARUS *Mantelli* of M. Desmarest (*Crust. Foss.* p. 130.) is, I believe, from Sussex, but as I have some doubts on the subject, it is not noticed in this volume.——Vide *Histoire Naturelle des Crustaces Fossiles, par A. Brongniart, et A. G. Desmarest.* one vol. 4to. with Eleven Plates, price 1*l.* 1*s.*

I.

PRELIMINARY ESSAY.

ON THE CORRESPONDENCE BETWEEN THE MOSAIC ACCOUNT OF THE CREATION, AND THE GEOLOGICAL STRUCTURE OF THE EARTH.

(IN A LETTER TO THE AUTHOR.)

Dear Sir,

Sound philosophy, and revealed religion, are naturally connected with each other. However widely they may differ as to the manner in which they severally proceed, they are both professedly tending towards one common object,—the establishment of truth. Philosophy sets out in its pursuit of this object, from the lowest point,—Religion from the highest: the former begins with the last effect, the latter commences with the first cause. Hence the mutual advantages to be derived from alliance are obvious; for where both parties are found to arrive from various directions, at the same conclusions, each will acquire an increased degree of confidence, as to their attainment of the grand object which both had in view.

With these ideas respecting the general connexion which ought to subsist between philosophy and religion, you will perhaps excuse my taking the liberty of sending you a few observations, relative to their particular connexion, with respect to that department, on which you have publicly announced your intention of entering.

Geology and religion are inevitably brought into contact, on the great point of the creation of the world, and it appears to me highly desirable to ascertain, whether each, when rightly understood, does not declare the same thing on this interesting subject.

Now I am aware that some of the commonly received opinions respecting the Mosaic account of the creation, are entirely at variance with the inferences reasonably deduced from the researches of Geology.

But common opinions are often far removed from truth, and it might be particularly expected, that they would be erroneous in such a case as the present. The ordinary Christian, rarely looks to the Bible with a philosophic eye; even where the opportunity and power of close examination exist, it is seldom that men inquire farther than into the authoritative evidence in favour of revelation; and finding that evidence sufficient to satisfy their minds, they at once receive the Bible as the Word of God.

The same conviction which leads them to this implicit faith in the Bible, as containing a revelation of divine truth, leads them also to look to it without the smallest reference to the deductions of science. It is viewed simply as the great repository of religious instruction; and even the historical parts, are rarely considered in any other light, than as the vehicles of improvement under the form of example. Hence it happens, that we are particularly liable to error, with respect to those parts which incidentally touch upon scientific points. Even the best informed and most serious Christian, never having been accustomed to consider them scientifically, is in great danger of giving way to vulgar prejudices, and thus of falling into the most palpable mistakes.

Our consideration of the Mosaic account of the creation, will present us with more than one instance of this description.

It will probably occur to most readers that they can recollect the time when they presumed that every night and day mentioned in the first chapter of Genesis, must be strictly confined to the term of twenty-four hours; though there can be no doubt but that Moses never intended any such thing. Critics moreover inform us, that his words ought never to have been so translated as to lead us into the suspicion, that he intended to make any declaration to this effect.

We are told that the word which is translated DAY, does in fact, signify an indefinite period of time; but common sense ought to have led us to the same conclusion, in regard to the three first days. For how could Moses intend to limit the duration of the day to its present length, before, according to his own shewing, the sun had begun to divide the day from the night.

But there are other prevailing errors with respect to the Mosaic account, of much greater consequence as touching the discoveries of Geology.

Moses is generally understood to give a *particular* description of the Creation of the World out of nothing; and he is supposed to fix the date of this creation, to a period, either immediately previous to, or actually contemporary with the three first days afterwards mentioned.

But surely these suppositions are wholly gratuitous. All that Moses says of the creation of gross matter is, 1st, that it was created by God; 2dly, that this creation took place in the *beginning*. Nothing can be more summary than the first of these declarations, nothing can be more indefinite than the second.

First, as to the *manner* in which the mass of the earth came into existence, we are left wholly in the dark; Moses simply declares it to be a *creation;* and he claims the glory of its creation for the one true God.

Secondly, as to the period when this mass was made, he only says that it was in "the beginning," a period this, which might have been a million of years before, just as well as on, or immediately previous to, the three first days. But that it could not have been *on* these days, appears to me plain from Moses' own words in the second verse; "And the *earth was* without form, and void, and darkness was upon the face of the *deep*, and the spirit of God moved upon the face of the *waters*." Moses here describes an intermediate state of our planet, between the creation in the beginning, and that of the six days; and it is especially remarkable, that he speaks of the *earth* and *water*, as being actually in existence during this intermediate state—"The earth *was*"—"the deep" of "waters" also *was*.

The force of these remarks is much increased, *first*, by the negative circumstance, that Moses afterwards passes on to the creation of light, atmosphere, &c. without the most distant allusion to any other creation of *earth* and *water* *.

Secondly, by the positive circumstance, that in verses 6, 7, and 9, he evidently speaks of *land* and *water* again, as already existing, and probably existing much in their present state; except only, that the water covered the earth, and the continents of the earth which lay buried beneath the water, had not their present superficial form; " *The earth was without form.*"

On these grounds, I may perhaps be allowed to infer, that the common opinions above stated are erroneous.

These opinions being removed, it appears to me that the Mosaic account of the creation, tallies with the inferences deducible from the discoveries of Geology, in the most remarkable and satisfactory manner.

First, it carries back the original creation of the solid mass of the earth, to an indefinitely distant period, beyond the first date given in verse 5.

Geology infers the immense antiquity of the earth, from the numerous strata of which it appears to be composed, lying one above the other, and many, if not all of them, bearing strong marks of their having been gradually formed.

2dly. The Mosaic account signifies that this planet was subject to great and violent revolutions, of which it gives one remarkable instance, in the chaotic state, which immediately preceded the present creation †.

Geology infers the same thing, from the forced positions of the strata, and from the various materials of which they are composed.

---

* He describes God as saying, " Let the light be, &c." but he never represents him as saying, " Let the earth or the water be," which most undoubtedly he would have done, if he had intended to give us the same particular account of the creation of the gross matter of the planet, as he has done of what may be called the furniture with which it is at present provided.

† We may consider Noah's deluge as the second instance of the same nature, though it was carried to a less extent. It is remarkable, that St. Peter, speaking of this event, describes it as a perishing of the world. Of any other revolution it did not come within the design of Moses to speak, as the great purpose of his account was to furnish man with a history of his own race.

The New Testament however, supplies an instance of a *third revolution*. See the following note.

3dly. Moses, so far as he goes, countenances the opinion that the earth's crust was formed from *water*, since he represents the whole earth as *covered with* W*ATER*, and the "Spirit of God moving," or brooding, "upon the waters."

The Geologist concludes, that even the granite which forms the peaks of the highest mountains, has been deposited from water, since it is full of regular crystallizations[*].

The secondary strata are decidedly traced to a similar origin.

4thly. While the Mosaic account *leaves abundant room* for the presumption, that the earth may have been inhabited, at one or more than one period, previously to the present order of things, it clearly shews that whatever beings may have existed, they were either wholly, or partly different, from those by which the earth is now tenanted.

Moses declares that at the chaotic period, the earth was "void," that is, according to Patrick, "having no beasts, or trees, or herbs, or any thing else wherewith we *now* behold it adorned."

Geology appears to establish the fact, that there must have been an order, or orders of created beings in existence, previously to the present; and it shews, that this order, or these orders, must have been principally different from that now on the earth[†].

---

[*] This remark is inferred, from what M. Cuvier says in the 7th chapter of his Essay on the Theory of the Earth, but I am aware that it is open to objection: the crystallizations alluded to, might have taken place, after a state of igneous fusion. I cannot help noticing here, that while Moses leads us to infer, that the great agent in the earth's last grand revolution, was *water*, the New Testament tells us, that the great agent in the earth's next revolution, will be *fire*.

Whether *water*, or *fire*, had been instrumental in operating any former revolutions, it was not the object of the Writers of the Old, or New Testament, to inform us. The observations of the Geologist would lead us to suppose, that each might have been in action, at different periods; and the Bible supports this supposition,—but, let it be especially observed, that it is not committed in the support of it, any farther than as regards the earth's last, and its now approaching revolutions.

[†] Those fossil animals which are satisfactorily identified with the present species, and which are found in situations where it is impossible to account for their appearance, from the action of any of those existing causes, which are now operating in the production of strata, may generally be carried back to the time of the deluge.

The solitary instance of *man* in a fossil state, which is preserved in the British Museum, was obtained from a very recent formation on the island of Antigua: (see page 254 of Jameson's Cuvier, where it is questioned whether the man was not a *Carib.*) Cuvier decidedly

5thly. On the presumption that the earth was inhabited previously to the chaotic period, the Mosaic account leads us decidedly to conclude that the whole former order of creation had perished, through want of the due support from light and atmosphere. In declaring that the present light and atmosphere were not called into existence till the first and second days, Moses leads us necessarily to infer, that during the period immediately previous to these days, there had been no light and atmosphere.

Now it will be very difficult for the Geologist to give any explanation of certain common phenomena in his province, without having recourse to some inference, similar to that just derived from the account of Moses *.

The immense accumulations of fossil animals, can hardly be attributed to any thing less, than the absolute destruction of *whole* orders of creation. The state also in which these animals are continually found seems to require, that they should have perished in some such manner as that which I have just inferred from the Mosaic account. In numerous instances, the organs of life appear to have been in the most perfect condition to the last. And yet they seem to have died without violence, in the most quiet manner, as it were by suspension of animation. This observation is the more remarkable, as a great proportion of these animals are aquatic, and appear to have perished thus quietly in the midst of their own element †.

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asserts that no fossil bones of man have been found, which can be attributed to a date prior to the revolution which preceded the deluge. The following observation of the same author is worthy our particular notice, with reference to what has been advanced in this note. "The bones of species which are apparently the same with those which still exist alive, are never found except in the very latest alluvial depositions, or those which are either formed on the sides of rivers, or on the bottoms of ancient lakes and marshes now dried up, or in the substance of beds of peat, or in the fissures, and caverns of certain rocks, or at small depths below the present surface, in places where they may have been overwhelmed by debris, or even buried by man."

* I find that Cuvier (chap. 5.) endeavours to account for the extensive destruction alluded to under this head, by presuming that the animals perished in consequence of exposure to various and disagreeing fluids. Marine animals died on exposure to fresh water inundations, and fresh water animals vice versa. Surely this theory is liable to objection, particularly where it is found that several distinct marine formations, all equally filled with marine animal remains, succeed each other.

† Any inundation like that of the deluge, which was not acompanied by a loss of atmosphere, would be utterly insufficient to account for so extensive a destruction, among tribes of

A circumstance which is easily explained on the supposition, that they died in consequence of losing the support of the atmosphere in which they had lived.

6thly. Resuming our former presumption, that the earth was inhabited previously to the chaotic period, and adding the further inference, that the whole of that former order of creation had been destroyed at that period, we are plainly taught, that all the remains of that order, were, during the same period, subjected to the various operations of the immense body of water, with which the earth was covered.

This again, is exactly what Geology seems to require, from the *various* states in which fossil remains are found.

Though some, from having probably been protected by inequalities in the earth's surface, or from other unknown causes, are found in almost the exact state in which they were at the moment of death; others have evidently been subjected to the greatest violence. The hardest animal substances have been, as it were, ground to the smallest pieces, by the action of the waters; and then, by the subsequent stagnation of the waters, they have been suffered to settle into a mass of compact rock. Perhaps also, the confusion as to climate which is observable in the fossil creation, may be attributable to the force of the chaotic waters *.

Let us now turn our attention to a few points, in the account which Moses gives, of the present order of things.

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animals, to which such a catastrophe would be but partially, and accidentally prejudicial. Of Noah's deluge we may observe, that the water subsided gradually, allowing time for most of the water animals to escape, and leaving the orders of testacea to be almost the only sufferers. Probably the aquatic remains of this event, which may be found in various parts of the world, will, on inspection, prove to be chiefly of this description. I cannot allow the present opportunity to pass, without noticing, that the deluge (however inconsiderable it may have been in its effects, when compared with chaos, or the end of the world,) is a most important event with reference to our present subject, as it affords an instance of a revolution "sui generis;" a revolution, in which a partial destruction of the organized creation must have taken place; and it is well worthy of remark, that this partial destruction must have affected in a more especial degree that species of animals, whose remains are found in such preponderating quantities in the bowels of the earth.

Cuvier at the conclusion of his essay, remarks, that it has not yet been explained why *shells* should be found almost every where, while fish are confined to a few places.

* Vide page 12, and note.

The works of the two first days do not come within the limits of geological inquiry; yet I cannot help noticing, that though Moses speaks of an original creation of light and atmosphere, he does not forbid the presumption, that the earth had enjoyed light, and atmosphere, previously to the chaotic period.

In the second day's work, moreover, an operation is described, which is exactly such, as geology seems to require, for the original deposition of strata. It is to be presumed, that the body of water with which the globe was covered, held a quantity of earth in suspension and solution.

Now during the second day, or period of time, when a *firmament* was made, we are told that *the waters were divided, and a great body of them was elevated in the form of vapour.*

The natural consequence of this operation, would be the deposition of a vast body of earth; I say, such would have been the natural consequences of this operation, for no positive inference on this point, can be drawn from the words of Moses; and much less can we infer any thing from Moses, as to the extent of the effects produced. We must presume, however, that its effects could only have been superficial, as the mass of the earth had been created before; and as geology gives us reason to conclude, that no very great deposition of strata has taken place, since the last order of creation perished.

The only purpose, therefore, for which I would be understood to make the above remarks, is to shew that tendency of the Mosaic account to which I have already alluded, viz. its leading us to infer, that the last crust of the earth was formed by deposition from water.

The next work described is more decidedly to our purpose, and most remarkably illustrates the observations of the geologist. On the third day Moses represents the Almighty, as willing, *first,* that the waters should be gathered together into one place; *secondly,* that the dry land should appear. Here are two operations exactly corresponding with what the geologist declares to be necessary, in order to account for the present appearance of the immediate surface of the earth.

Cuvier observes, that the present continents must have been formed by the recession of the water, and the elevation of the earth [*].

With respect however to the second operation mentioned by Moses, it appears to me sufficient to account for many circumstances in the earth's form, which are most perplexing to the geologist.

The elevation of our present continents above the level of the basins which contain the waters of the ocean, the irregularities which occur in the strata of which these continents are composed, their inclination, dislocation, &c. clearly shew to the geologist that they must have been subjected to very great violence; violence proceeding from some cause far more powerful than any at present known to be in ordinary operation on the earth [†].

Such a cause is undoubtedly to be found, in the express will of the great Creator; and surely it cannot be thought fanciful, to suppose that when God said "Let the dry land appear" this cause actually produced the above extraordinary effects [‡].

This remark seems to gather much force from the observations of Cuvier, in the Essay already so often referred to. He professedly devotes a great part of the 31st chapter to the proof of the proposition, that "the present surface of the earth is not of very ancient formation." In the beginning of his last chapter, he distinctly states, that "if there be any one circumstance thoroughly established in geology, it is that the crust of our globe has been subjected to a great and sudden revolution." And while as to the manner of this revolution, he again speaks of the bed of the last ocean being laid dry, (according to Moses the dry land appearing at the word of God,) as to the date of this revolution, he makes this most important remark: "The epoch of this revolution cannot be dated much further back than five or six thousand years." A period this, strikingly corresponding with the date probably to be assigned to the third day of the Mosaic creation, which, on the presumption that the following days *after* the first appearance of the sun, were actually days of the present length, will be about 5820 years. This coincidence is the more valuable, as it is plain that it does not arise from any intention in M. Cuvier, to accommodate himself to the account of Moses.

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[*] It is unnecessary to refer to particular passages, as M. Cuvier repeatedly alludes to both these operations in his Essay on the Theory of the Earth.

[†] "The thread of operation is here broken, the march of nature is changed, and none of the agents which she now employs are sufficient for the production of her ancient works." Cuvier, chap. 8.

[‡] I would by no means be understood to signify, that all the irregularities in the earth's strata, are to be traced to this single epoch, many may have occurred in the course of former revolutions of the earth.

Indeed it is remarkable, that the only revolution for which Cuvier has recourse to the authority of the word of God, is that of the deluge, and the date of this event will bring him considerably short of the latest period, which he has himself fixed for the last great catastrophe. I cannot leave the present point without observing, that Cuvier states it as his own opinion, that even the primitive strata were more or less affected by the last revolution of which we have been speaking. In the fourth and seventh chapters, he has these striking remarks:—having before spoken of the previous revolutions, by which those primitive masses which now form the peaks of the highest mountains, were originally "lifted up," at the end of the seventh chapter he observes, that "these primitive masses have also suffered other revolutions *posterior to the formation of the SECONDARY strata*, and have perhaps given rise to, or at least have partaken of some portion of the revolutions and changes, which these latter strata have experienced." There are actually considerable portions of the primitive strata uncovered, although placed in lower situations than many of the secondary strata, and we cannot conceive how it should have so happened, unless the primitive strata in these places had *forced themselves into view after the formation of those which are secondary*. Cuvier mentions other remarkable circumstances tending to establish the same point.

I find from Dr. Kidd's excellent work on Geology, that he agrees with Saussure and De Luc, in supposing that operations of a nature very similar to those above inferred from the Mosaic account, must have taken place shortly previous to the appearance of the present order of creation on the earth's surface. Saussure was of opinion that there had been a great earthquake, or movement of the solid mass of the earth, beneath the chaotic ocean: and that this movement had been followed by a most violent irruption of the waters, after which irruption the waters gradually subsided; for which gradual subsidence the Mosaic account affords sufficient room in the indefinite duration of the third day. I cannot pass over, in this place, Saussure and De Luc's united opinions, that the human race cannot be very old. They would seem indeed, according to Dr. Kidd's representation, to be decidedly of opinion, that the origin of the human race must be dated subsequent to the above catastrophe; and though they do not, like Cuvier, go so far as to date that catastrophe, yet they would plainly lead us to conclude, that that catastrophe was the last which had materially affected the crust of the earth; that since it had occurred, the earth's surface had continued much in its present state; as even the very boulders which it had produced had not been removed, nor yet, in all cases, covered.

Before I leave the consideration of the Mosaic account, I cannot forbear offering a few observations on the passage from verse 14 to 19*.

Now in this passage, Moses surely cannot be understood to speak of the first creation of the sun and planets, for he had told us before, that God had made them in the beginning; Moses therefore must here be understood to signify, merely that God now gave them a fresh regulation with respect to the earth and to each other.

With respect to the earth, he tells us, that they were now made to serve as lights: and being lights, they became further useful, by their own and the earth's mutual motion, to distinguish *times* and *seasons*.

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* To guard against the imputation of rashness in consequence of the observations which I have presumed to offer on this passage, let me request the reader's very attentive perusal of the following most excellent note, extracted from the works of Bishop Beveridge, and cited by the learned editors of the Family Bible lately published by the Society for promoting Christian Knowledge.

"We must distinguish betwixt God's saying let such a thing *be*, and let such a thing *do*, so or so. By the first, he produced the thing out of nothing; by the other, he gave laws to it, then in being. As when he said, 'Let there be light,' by that word, the light which was not before, began to *be*; but when he said, let there be light in the firmament to divide the day from the night, &c. he thereby gave laws to the light he had before made, *where* he would have it *be*, and *what* he would have it *do*. This is what we call the law of nature; that law which God has put into the nature of every thing, whereby it always keeps itself within such bounds and acts according to such rules as God has set it, and by that means shews forth the glory of his wisdom and power."

That Moses must be understood to speak, not of the planets themselves, but only of their becoming lights with respect to the earth, is evident, not only from the circumstance of his having previously mentioned their creation, in the first verse, but also, from his detaching the creation of light, from what is afterwards said to be the making of the sun, moon, and stars. This latter circumstance plainly shews, that Moses understood light, to be quite independent of the heavenly bodies. Having therefore previously spoken of the separate and independent creation of the heavens and the light, we may conclude, that in the passage under consideration, he could only have intended some fresh regulation respecting them, and this regulation could only have been that which he very clearly describes. They became the great points from which light was to be communicated to the earth*. And as by the communication of light, they now first, after the period of chaos, in which darkness prevailed†, became visible from the earth, they now first, after the same period, became useful for the purpose of marking the change of day and night, summer and winter.

Whether they had ever served the same purpose before this period, under any former order of things, it did not come within the intention of the Mosaic account to declare, though nothing in that account forbids such a supposition; and it is open to the geologist to draw what inferences he can, from the presumed nature of the fossils he meets with‡, and from the actual situations in which he finds them.

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* Herschel's conjecture that the sun's light is only communicated, and that it arises from luminous nebulæ surrounding a solid and habitable orb, strikingly illustrates this part of the Mosaic account.

† What may have been the state of other planets of our system during the period of darkness with respect to the earth, it were equally useless and unavailing to inquire; but I cannot forbear observing, that the instances, *first*, of the earth itself on the original creation of light, *secondly*, of Saturn with his ring, shew that each planet may have had light independent of the sun.

‡ I am informed that all the fruits which have been found in a fossil state are *tropical*. This would seem to favour the presumption that the earth did not formerly receive light in the same way as at present.

I must now conclude with a few general remarks on the account which Moses has left us of the creation.

It is plain to common sense, that he had not the most distant idea of entering into, or accommodating himself to philosophical inquiries.

His first object was to claim for the God of Israel, the glory of having created the whole visible universe. His second object was, to give an account of the origin of man, and of that order of things which first began to exist at the same time with man.

Such being manifestly the sole objects of Moses, all we can reasonably expect from him touching scientific points is, *first*, that he should say nothing directly contrary to the *certain* conclusions of philosophy.—*Secondly*, that he should furnish some few hints in aid of such conclusions. It appears to me that he has answered both these expectations; and in answering them, he has given a strong proof that he wrote under the direction of wisdom superior to his own. When alluding thus to the divine authority of Moses, it will be necessary that I should guard against a misapprehension of my meaning. I would by no means intimate, that the writings of Moses need any support from reasonings, such as those into which we have been led. The authoritative and moral evidence to which I have referred in a former part of this letter as sufficient to satisfy the generality of inquirers, is the great, and only true ground, on which the authority of Moses always has rested, and always must rest.

But while on this ground, I firmly believe that "God spake by Moses," I am glad to find that *evidence* which brings me to the same point, and which comes even home to my senses, has been furnished by the researches of geology.

I am,
Yours, &c.

II.

GEOGRAPHICAL DESCRIPTION OF THE SOUTH-EASTERN DIVISION OF SUSSEX.

Sussex is a maritime county, bordered on the west by Hampshire, on the north by Surrey, on the east and north-east by Kent, and on the south by the British Channel[*].

The strata of which it is composed, form three principal groups, each possessing characters that materially affect the geographical features of the county, and present a striking instance of the intimate relation that exists between the physical appearance of the surface of the earth, and its geological structure. The popular division of this tract into the Downs, Weald, and Forest-Ridge, may therefore be considered as sufficiently correct and comprehensive for our present purpose, since it is descriptive of the external characters of the district, and is agreeable to the natural arrangement of the strata.

The Downs[†] are a chain of hills covered with a fine verdant turf, possessing in a striking degree that smoothness and regularity of outline, for which the mountain masses of the chalk formation, are so remarkable. Commencing with the bold promontory of Beachy-Head, they traverse the county in a direction nearly east and west, and pass into Hampshire near

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[*] "Northernmost point *Black-Corner*, N. lat. 51° 9'.—48' long. W. of Greenwich.
Southernmost . . *Selsey Bill*, N. lat. 50° 43'—47' W. long.
Easternmost . . *Kent Wall*, N. lat. 50° 56'—49' E. long.
Westernmost . . *Stansted Park*, N. lat. 50° 53'—58' W. long.
Dallaway's History of the Western Division of the County of Sussex, 4to. 1815, vol. i. p. 5.

[†] "Though I have now travelled the Sussex Downs upwards of thirty years, yet I still investigate that chain of majestic mountains with fresh admiration, year by year. This range, which runs from Chichester east as far as Eastbourne, is about sixty miles in length, and is called the South Downs, properly speaking, only round Lewes." *Natural History of Selbourne*, 1802, *p.* 276.

Compton. Their length is between fifty and sixty miles, their greatest breadth seven miles, and their mean altitude about five hundred feet above the level of the sea. Their northern escarpment is in general steep and abrupt, but on the south they descend by a gentle declivity, and unite almost imperceptibly with the low lands of the coast.

From Beachy-Head to Brighton, they present an immediate barrier to the sea, forming a bold and precipitous line of coast; but proceeding westerly, they extend inland in an oblique direction, and occupy the centre of Western Sussex. From this circumstance, a considerable difference exists in the geological relations of the eastern and western divisions of the county; the latter being characterized by a range of chalk hills in the centre, with a maritime district formed of clay and gravel on the south, and a weald composed of sand and clay on the north.

Throughout its whole extent this chain exhibits decisive manifestations of the action of water; not only are the ridges and summits of the hills rounded and even, but their surface is every where furrowed by coombes, or narrow undulating ravines; these uniting terminate in vallies, that intersect the downs in a direction nearly north and south, and form extensive outlets for the rivers that flow from the interior of the country into the British Channel. The course of the smaller excavations or coombes is exceedingly various, but their general bearing is east and west; they gradually increase in breadth as they descend, and their opposite sides have corresponding angles and sinuosities; this appearance however is not observable in the principal vallies.

The chalk hills of Sussex are separated into five distinct masses, by the following rivers; viz. the *Arun*, the *Adur*, the *Ouse*, and the *Cuckmere*.

The first is situated in Western Sussex: it rises in the forest of St. Leonard, near Horsham, and taking its course to the westward for a few miles, turns suddenly to the south, passes through the chalk near Arundel, and falls into the sea to the west of Little Hampton.

The Adur constitutes the western boundary of the South Downs, properly so called; like the former, it has its origin in St. Leonard's forest, and passing by Steyning and Bramber, enters the British Channel at New Shoreham.

The Ouse, which is the principal river in the south-eastern part of the county, rises by two branches; the one has its source in St. Leonard's forest, and the other in the forest of Worth, north of Cuckfield. The river formed by the confluence of these streams pursues a tortuous course to the southward, and passing to the east of Lewes, which it separates from the adjacent town of the Cliff, flows through the flat alluvial tract of Lewes Levels, and discharges itself into the sea at Newhaven harbour.

The Cuckmere has its source near Warbleton, and being augmented by numerous tributary streams, in its course by Hellingly, Arlington, Alfriston, &c., falls into the British Channel at the haven which bears its name.

By these rivers the drainage of the country is effected, and it is worthy of observation, that they invariably flow from an older over a newer country; or, in other words, that the strata forming the district from whence they take their rise, are of anterior formation to the chalk vallies by which they empty themselves into the ocean.

The Weald * of Sussex, is an extensive vale that occupies the centre of the south-eastern part of the county, and running parallel with the Downs, forms their northern boundary. It was anciently an immense forest, (called by the earlier colonists *Coid Andred*, by the Romans, *Silva Anderida*, and by the Saxons *Andreadswald*,) which even in the time of Bede, was a mere retreat for deer and swine; the greater part is now in an excellent state of cultivation. It consists of various beds of clay, sand, and limestone, and is comparatively of low elevation: its breadth is from 5 to 10 miles, and its length from 30 to 40 miles; it is estimated to contain 425,000 acres. The surface is intersected by numerous vallies, which generally occur at the outcrop or basseting edges of the strata, and form channels for the numerous streams that are tributary to the rivers in their vicinity. The whole tract rises with a gradual sweep from the foot of the Downs, and unites with the higher lands of the forest ridge.

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* "Opposite to the South Downs on the north are the Surrey hills falling abruptly southward, and sloping gradually to the north, and between these two lines of hills, is the Weald of Sussex and Surrey." *Young's Agricultural Survey.*

The FOREST-RIDGE constitutes the north-eastern extremity of the county. It is composed of the more elevated portions of the sand formation, and from the rocky and abrupt termination of its ridges, which are for the most part either crested with forests, or overgrown with underwood, forms a tract of country remarkable for its romantic and picturesque scenery. The principal heights in this range are Wych Cross, Brightling Down, Dane's Hill, Fairlight Down, and Crowborough Beacon; the last mentioned is the highest and most central eminence, and is 804 feet above the level of the sea.

"The climate in the western part of the maritime division is very warm, and highly favourable to the powers of vegetation. The Downs fronting the south-west are bleak, being exposed to violent winds, which are impregnated with saline particles, occasioned by the spray beaten against the sea-beach; and this influence affects the animals as well as vegetables indigenous to the hills. In the Weald the due circulation of air is greatly impeded by the forests and thick hedges, and the climate is in consequence cold and damp [*]."

Such are the geographical features of the masses which compose the county of Sussex; but as our present investigation has a more immediate reference to the south-eastern division, it will be necessary to point out with greater precision the course and position of the chalk hills of that district, and more especially of those in the vicinity of Lewes and Brighton.

The South Downs are that portion of the Sussex range which lies between Eastbourne and Shoreham. They are twenty-six miles long, about seven miles in breadth, and are divided by the intervention of rivers into four groups.

The easternmost rises with a gentle slope near Eastbourne, proceeds inland as far as Folkington, and is separated from the middle division by the Cuckmere. The southern escarpment composes a rocky and precipitous range of cliffs, extending eastward along the coast from the embouchure of Cuckmere river to Beachy Head, where it rises to the altitude of 564 feet.

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[*] *Dallaway's Western Sussex*, page 6.

The middle group is bounded on the east by the line of separation above mentioned, on the west by Lewes levels, and on the south by cliffs which reach from Cuckmere haven to Seaford point, from whence to Newhaven harbour it is skirted by a low marshy coast; the northern margin is formed by the elevated ridge of Firle hills.

The western division embraces the most considerable extent of Down in the county. The Adur forms the natural limits of this chain on the west, and the Ouse on the east; the southern slope is washed by the British Channel, except towards the south-west, where a flat maritime district, extending from near Brighton to Shoreham harbour, intervenes and separates it from the sea-shore. The ridge by which it is bounded on the north, presents a steep escarpment to the Weald, and is the highest land in the county, Ditchling beacon, the centre of this line, being 864 feet above the level of the sea. Eastward of the beacon lies Plumpton plain, an elevated platform commanding an extensive view of the rich scenery of the Weald on the one hand, and of the Downs and British Channel on the other. Ray mentions the prospect from this spot as equal to any he had seen in the finest parts of Europe, extending 30 miles towards the sea, and 40 miles inland to Surrey *.

Brighton and Lewes, two of the principal towns in the county, are situated in this division of the South Downs. The former lies nearly in the centre of the southern edge, on the margin of an extensive bay, comprehended between Beachy Head and Selsey Bill, and is sheltered by a range of hills on the east, north, and north-east: the peculiarities of its site, and the structure of the cliffs in its vicinity, will be hereafter particularized.

Lewes is delightfully situated on the eastern extremity of this range;

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* *White's Nat. Hist. of Selbourne*, 1802, page 276.

it lies 50° 52′ north latitude, and is distant 50 miles south from London. The Downs form an amphitheatre of hills to the east and west of the town; but the northern and southern slopes are skirted by the Levels.

The CLIFF HILLS constitute the last division of the South Downs; they are a small insulated group, separated from the central and western chains by the intervention of Lewes Levels. The edge of this range runs parallel with the road from Southerham to Glynd and Glyndbourne, passes near Ringmer in its course westward, and terminates at Old Malling near the banks of the Ouse. The south-eastern angle is formed by Mount Caburn, and the western escarpment is deeply indented by the steep valley of the Coombe.

"The soil of the Downs is subject to considerable variation. On the summit it is usually very shallow; the substratum is chalk, and over that a layer of chalk rubble, with a slight covering of vegetable mould. Along the more elevated ridges there is sometimes merely a covering of flints, upon which the turf grows spontaneously. Advancing down the hills the soil becomes deeper, and at the bottom is constantly found to be of very sufficient depth for ploughing: here the loam is excellent, generally ten or twelve inches thick, and the chalk rather broken, and mixed with loam in the interstices*."

Some parts of the South Downs are converted into arable, but in general they are reserved for pasturage, and support a breed of sheep equal, if not superior, to any in the kingdom†.

LEWES LEVELS, which have already been mentioned as intervening

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* *Young's Agricultural Survey of Sussex*, 8vo. page 5.

† The sheep fed on the South Downs amount to nearly 200,000; and as there are no natural springs on the chalk hills, the flocks are supplied with water from large circular ponds, made on the summits of the Downs; the bottoms of these excavations are covered with a layer of ochraceous clay, to prevent the water from percolating through the chalk, and they are seldom known to fail even in the hottest summers. The late Mr. White considered this circumstance as very remarkable, and has particularly noticed it, in his interesting volume on the Natural History of Selbourne. "To a thinking mind few phenomena are more strange than the state of little ponds on the summits of chalk hills, many of which are never dry in the most trying droughts of summer: on chalk hills, I say, because in many rocky and gravelly soils, springs usually break out pretty high on the sides of elevated grounds and mountains; but no person acquainted with chalky districts will allow that they ever saw waters of so pervious a stratum as chalk, all lie on one dead level, as well-diggers have assured me again and again.

"Now we have many such little round ponds in this district, and one in particular on one between the western and central divisions of the South Downs, form a marshy alluvial plain, through which the Ouse winds its way to the British Channel. This tract consists of silt, clay, and peat, and is nearly ten miles long; its breadth varying from half a mile to two miles and a half. Towards the north-western confines of this plain, are two remarkable oval mounds or hillocks of chalk marl, situated at a short distance from each other, near the borough of Southover. They bear the name of Rhies, a provincial term derived from the Saxon *hryg*, a heap, or longitudinal projection*, and are about seventy feet high, and from two to three furlongs in length.

The sketches comprised in Tablet II. will, it is presumed, assist in illustrating the relative position of the several chains of hills by which this district is traversed, and remove any obscurity that may occur in the preceding description.

No 1. presents an outline of the southern aspect of the country in the vicinity of Lewes, taken from a mill near the town; it shews the Firle and Newhaven hills, the extensive tract of marsh land that fills up the interval between them, and the *Rhies*, which are situate in the midst of the Levels.

The view from the eastern brow of Mount Harry, No. 2, exhibits the relative situation of Beachy Head, Firle and Newhaven hills, and several other ranges of Downs, that either have been already noticed, or to which we may have occasion to refer in the course of these investigations.

No. 3. is a profile of Cliff Hills; it exposes a partial section of the strata, and points out the situation of several of the principal chalk-pits in the vicinity of Lewes.

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sheep down, three hundred feet above my house; which though never above three feet deep in the middle, and not more than thirty feet in diameter, and containing perhaps not more than two or three hundred hogsheads of water, yet never is known to fail, though it affords drink for 3 or 400 sheep, and for at least 20 head of large cattle beside." *White's Nat. Hist. of Selbourne*, p. 206.

What however appears to me more extraordinary is the fact, that soon after a new pond has been made, and has received a partial supply of water from a few passing showers, it becomes inhabited by various kinds of fresh-water plants and shell-fish, and even frogs and lizards; although it may be remote from any other pond, and at an elevation of four or five hundred feet above the level of the surrounding country.

* *History of Lewes*, 8vo. 1795, page 416.

III.

GEOLOGICAL STRUCTURE OF SUSSEX.

The investigation of the geological structure of this district is attended with considerable difficulty. The displacement and disintegration which some of the strata have sustained; the excess of soil and vegetation with which in many places their basseting edges are covered at the line of junction; and the absence of sections in those situations where the relative position of the rocks is involved in obscurity, present numerous, and, in some instances, insuperable obstacles, to accurate examination. Under such circumstances, induction and analogy must supply the place of actual observation; but the relative position of the principal masses having been correctly ascertained, whatever errors may have originated from the causes alluded to, are of minor importance; since they chiefly relate to the geographical extent of the strata, and cannot affect the geological deductions that may be drawn from these researches.

For the information of the general reader, it may be necessary to observe, that in Sussex, as in every other part of England, the strata maintain a certain order of superposition, and that however great the displacement or interruption they may have sustained, this order is never inverted. To illustrate this remark, we may observe, that the *blue chalk marl*, which separates the *grey chalk marl* from the *green sand* at Hamsey, Ringmer, and Laughton, is altogether wanting at Eastbourne, and several other places; but in these instance the grey chalk marl reposes immediately upon the *green sand*, the relative position of the masses remaining unaltered, by the absence of the intervening deposit.

The following arrangement of the strata of the south-eastern division of Sussex, is that which, after much reflection, I have been led to consider as agreeable to their natural order of succession.

Order of Superposition of the Strata of the South-eastern Division of Sussex, (commencing with the lowest and most ancient Formation.)

SECONDARY FORMATIONS.

Formations.	*Principal Divisions.*	*Subdivisions.*	*Localities.*
§ I. GREEN SAND FORMATIONS.	i. Iron Sand.	Sand and sandstone, containing layers and concretions of ironstone.	Fairlight Down, Dane's Hill, Brightling Down, (alt. 646 feet) Crowborough Beacon, (804 feet alt.) Wytch Cross, Uckfield, Ashburnham, Ashdown Forest, &c.
		Shelly limestone, alternating with beds of blue shale and clay.	Hastings, Archer's Wood, near Ashburnham, Rotherfield, Framfield, Isfield, &c.
		Coal and lignite.	Bexhill, Newick, Waldron.
	ii. Tilgate Beds.	Sandstone, limestone, and limestone slate, reposing on blue clay.	Crawley, Handcross, Cuckfield, Tilgate, &c.
	iii. Weald, or Oak Tree Clay.	Blue and lead-coloured clay passing into marl.	Throughout the Weald of Sussex.
		Petworth, or Sussex marble.	Petworth, West Grinsted, Ditchling Common, Plumpton, Laughton.
	iv. Green Sand.	Containing thick beds and concretions of chert, with veins of chalcedony.	Haslemere, Bracksley Heath, Blackdown Hill, Tilvester Hill.
		White sand, and sandstone.	On the Broyle, near Ringmer.
		Red sand, and sandstone.	Ditchling, Norlington, &c.
		Green sand.	Broyle, Ringmer Park, Beech Wood, near Offham.
		Passing into iron sand, and containing concretions of ironstone,	Parham Park, Danny, near Hurstpierpoint.
		Alternating with and passing into soft grey sand.	Eastbourne.
§ II. CHALK FORMATIONS.	v. BlueChalkMarl.	Malm rock.	Western Sussex, near Bignor.
		Blue chalk marl or galt.	Ringmer, Laughton, Hamsey, &c.
	vi. Grey Chalk Marl.	Grey chalk marl.	Hamsey, Stoneham, Base of the Downs.
	vii. Lower Chalk.	With very few flints, and harder than the Upper Chalk.	Southerham: forms the lower portion of the Downs.
	viii. Upper Chalk.	With numerous beds of flints.	The South Downs.

TERTIARY FORMATIONS.

Formations.	*Principal Divisions.*	*Subdivisions.*	*Localities.*
§ III. FORMATIONS ABOVE THE CHALK.	ix. Druid Sandstone.	Boulders on the summits, plains, and vallies of the chalk, and in diluvial beds.	Lewes Race Course, summits and valleys of the Downs, Falmer, Shingle Bed at Brighton.
	x. Plastic Clay.	Ferruginous breccia, with pebbles of a greenish colour.	Chimting Castle, Newhaven, &c.
		Various beds of sand, marl, and clay, and of gravel formed of rolled chalk flints.	Castle Hill, Newhaven.
	xi. London Clay.	Clay containing fossils, the same with those of the *Calcaire grossier* of Paris.	Bracklesham Bay.
		Calcareous sandstone containing green earth.	Bognor Rocks.

ALLUVIAL DEPOSITS.

Formations.	*Principal Divisions.*	*Subdivisions.*	*Localities.*
§ IV. ALLUVIAL FORMATIONS.	xii. DILUVIUM.	Calcareous rubble, beds of gravel and sand.	Brighton Cliffs.
		Chalk rubble, and beds of ochraceous clay, with slightly rolled chalk flints.	On the summits, slopes, and in the vallies, of the Downs.
		Boulders of ferruginous breccia, Druid sandstone, &c.	Brighton Hills, hills near Piddinghoe.
		Clay, loam, and gravel, containing bones of land quadrupeds.	Near Brighton, Arundel, &c.
	xiii. ALLUVIUM, (the effect of causes still in action.)	Blue clay, silt, &c.	Lewes Levels.
		Tufaceous depositions.	Spring, near Pounceford.
		Sand and comminuted shells drifted inland by winds from the sea shore.	Near Shoreham.

The general inclination of the beds is towards the south-east, consequently, a line drawn from the west, through the interior of the country, would pass over the basseting edges of the strata in regular succession. On the surface the occurrence of a new formation is for the most part indicated by the intervention of a rivulet or valley, by a difference in the physical appearance of the country, and a corresponding change in the nature of the soil and its productions.

On the annexed map, I have delineated the *outcrop*, or geographical extent of the strata, with as much accuracy, and detail, as my time and opportunities for examination would permit, and have subjoined a section of the country, from Castle Hill, near Newhaven, to Little Horsted, which, with but one exception, comprehends the entire series of the Sussex formations.

The plan of the stratification, (Table 3, fig. 1.) is merely ideal, and intended to illustrate the arrangement of the beds, and convey a general idea of the geological structure of the district.

I shall now proceed to describe the strata according to their natural order of succession, beginning with the lowest or most ancient deposit.

IV.

§ I. GREEN SAND FORMATION.

In conformity with the arrangement of Professor Buckland, the whole of the Sussex beds below the chalk marl, are included in the present *formation*, although they differ most essentially from each other, both in their physical characters, and in the nature of their organic remains. But the term *formation* is now employed by geologists in a very extended sense, denoting not only a series of similar and contemporaneous strata, but also an assemblage of contiguous beds, which although differing from each other in dimensions, colour, constituent substance, mineralogical productions, and organic remains, are yet presumed to be more nearly related to each other, than to any other group of deposits.

V.

§ I. 1. IRON SAND,

CONSISTING PRINCIPALLY OF FERRUGINOUS SAND AND SANDSTONE, AND CONTAINING SUBORDINATE STRATA OF IRONSTONE, MARL, AND CLAY, WITH SHELLY LIMESTONE; ALTERNATING IRREGULARLY; AND ALSO BEDS OF WOOD COAL.

The iron sand is considered by Mr. Conybeare as the lowest of the formations which intervene between the oolites and the chalk. The sand and sandstone are entirely siliceous, and contain a great proportion of brown or yellow oxide of iron; often indeed in such quantity, that many of its beds were formerly worked for the purpose of obtaining the ore of that metal.

The texture of the sandstones is evidently mechanical, and they often form coarse-grained conglomerates, consisting of quartzose pebbles of various sizes, imbedded in a ferrugino-siliceous cement *.

The Forest ridge, and a considerable portion of the Weald, consist of this deposit, which rises from beneath the Weald clay, and occupies the north-eastern division of the county. It forms a range of hills which run in a W. N.W. direction from Hastings to near Horsham, having a soil either of sandy loam upon grit stone, or of black vegetable earth upon clay or marl. Its principal elevations have been already mentioned. A great proportion of these hills is but little better than barren sand, of which St. Leonard's and Ashdown forests are computed to contain nearly thirty thousand acres. The sterility of this extensive tract is ascribed to the ferruginous impregnation of the soil from the beds of ironstone.

On the coast, the ironstone is first seen near Bexhill, rising from beneath the marsh land of Pevensey Levels; from whence it forms a line of cliffs that extends to Hastings, and terminates near Winchelsea.

We shall proceed to notice a few localities of this deposit, in the south-eastern part of the county.

At Little Horsted, five miles N. N. E. from Lewes, the iron sand first appears; it is seen immediately below the turf on the brow of a gentle elevation near the forty-fifth mile-stone; and forms the hill on which Horsted church, and the seat of Ewan Law, Esq. are situate. On the east side of the road, the strata appear in the following succession, dipping towards the south-west.

1. Sand-stone of a ferruginous colour.

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* Extracted from a Memoir on the Iron Sand, by the Rev. W. D. Conybeare, F.R.S. published in the new edition of Phillips' Outlines of Geology, 1822. This interesting little volume is certainly one of the most valuable works on geology that has appeared in this, or any other country. It contains a complete epitome of all that is at present known concerning the geological structure of the British islands; and abounds with the most useful information.

2. Grey sand about 6 or 8 inches thick, containing minute fragments of charred wood.
3. Sandy marl two feet thick.
4. Sand and sandstone highly ferruginous.
5. White sand and sandstone.

On the southern slope of Horsted hill the sand is covered by a bed of peat, six feet thick, which extends over several fields, and is cut for domestic purposes.

The wells in the neighbourhood are about sixty feet deep, and have a constant supply of good water.

Proceeding northward, the sandstone presents a bolder outline, and rocks of considerable magnitude protrude through the soil on both sides of the road. The strata are from three to six feet thick, and are separated from each other, by thin layers of soft sandstone shale; their inclination is towards the south-west except in a few instances, where a contrary direction is observable.

In the immediate vicinity of Uckfield, grey sandstone rocks of low elevation are very numerous. Their summits are rounded and covered for the most part with coppices and underwood; but their sides are bare, and exhibit evident traces of diluvian action.

Near "The Rocks," the seat of Mrs. Jackson, about half a mile west of Uckfield, a group of sandstone rocks occurs, under circumstances of considerable beauty and picturesque effect. The path that leads to this interesting spot lies to the right of the road, and, by a circuitous route, conducts the spectator to the centre of a wood, when a beautiful lake, nearly surrounded by rocks, suddenly opens to the view. The cliffs, overhanging the water, are from twenty to thirty feet high, and are surmounted by forest trees and underwood. In some places the rocks are nearly perpendicular; in others they descend with a gentle slope to the water's edge, the declivity being covered by a luxuriant vegetation. On the northern margin, a projecting point of high rock is perforated by a natural archway, that has been enlarged by art, and this leads to a recess in the sandstone on a level with the bosom of the lake. From this point the picturesque beauty of the scene is exhibited to peculiar advantage. On the opposite shore, the base of a rock that juts into the water is in like manner excavated into an arch, beneath which a little shallop was moored at the time of my visit. In one of the vertical cliffs, some fine young birch trees had taken root between the thin layers that separate the strata, and in almost every fissure of the rocks numerous plants* had insulated themselves, and by the beauty and variety of their foliage, relieved the monotonous and sombre appearance of the smooth grey sandstone. On the less elevated masses, lichens, mosses, and heaths, were growing in great profusion and luxuriance. The strata are nearly horizontal, and partake of the characters of those already described.

A fine lake, overhung with sandstone rocks, and crested with a noble wood, near the seat of the Earl of Sheffield, in the parish of Fletching, might also be mentioned as affording another example of the picturesque scenery, to which the irregular surface of the sandstone gives rise in certain situations. Here, as in other parts of its course, the soil is in general sterile; but some spots near Fletching are remarkable for flourishing oaks: these contain six parts of sand, one part of clay, and a considerable proportion of finely divided vegetable matter. One hundred parts of this soil, analyzed by Sir Humphry Davey, gave the following results:

Silica - - - -	54 parts.
Alumina - - - -	28
Carbonate of lime - - -	3
Oxide of iron - - -	5
Decomposing vegetable matter -	4
Moisture and loss - - -	6
	100†

Near Long-ford, in the parish of Barcombe, a section is exposed by the road leading from Barcombe Cross to Newick Park. At this spot the sand bassets out from beneath the Weald Clay, and forms an elevated bank on the north side of the rivulet that flows along the line of junction. The beds of sand and sandstone are here nearly twelve feet high, and agree in their nature and relations with those which occur at Horsted.

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* Among others I noticed osmunda *regalis*, antirrhinum *cymbalaria*, polypodium *vulgaris*, polyp. *filix mas*, lichen *rangiferinus*, erica *vulgaris*, &c.

† *Davey's Elements of Agricultural Chemistry*, 4to.

Insulated portions of sand and sandstone rise to the surface near Isfield Paper-mill, and also on the opposite bank of the river; but from the quantity of soil and vegetation with which they are surrounded, their extent cannot be determined with any degree of accuracy.

On the coast, the cliffs near Hastings expose an interesting section of the iron sand. The strata are less ferruginous than in the localities previously described, and the sand is finer and more loose and friable; it sometimes contains impressions of ferns, charred wood, and the stems of vegetables.

At Rye the sand is highly ferruginous, and the sandstone of coarser texture.

It is unnecessary to describe the course of the iron sand and sandstone more minutely, as the strata, although distributed over a considerable extent of country, present but little variety, and are destitute of organic remains: the localities, already noticed, are sufficiently characteristic of their usual appearance and structure. We shall therefore pass to the examination of the ironstone, limestone, and coal, since the history of these beds possesses considerable interest in an economical, as well as a geological point of view.

1. IRONSTONE.

This substance is internally of a dark steel grey, and generally very hard and compact; occasionally it is laminated, and separates into thin flakes upon exposure to the air. It occurs either in irregular concretions in the sand, or is stratified and alternates with beds of sandstone. The globular masses often contain nodules of argillaceous earth, round which the ironstone is disposed in concentric layers.

In some parts of the county the ironstone is of excellent quality, and extensive founderies were anciently established in different parts of its course: "the almost inexhaustible quantity of wood, with which the country was covered in the early centuries, and the numerous lakes and morasses, which the total neglect of drainage had occasioned, being circumstances peculiarly favourable for the conversion of the iron ore into bars. For this purpose the lords of the several manors which lie within the woodland district collected the rivulets into large ponds, and erected mills and furnaces. The iron, so procured, was at first principally used for agricultural implements;" but Fuller also observes, in his Worthies, that "it is almost incredible how many great guns were made of the iron of this county. The total decline of the manufacture in Sussex is to be attributed to the establishments in Scotland and Wales, in which pit-coal is used, the superior cheapness of fuel having enabled them to monopolize the trade." There is now but a single foundery in the eastern division, and which belongs to the Earl of Ashburnham. According to the present practice, it requires fifty loads of charcoal, and fifty loads of ironstone (twelve bushels to each load) to make thirteen tons of pig iron*.

Mr. Young, in his "General View of the Agriculture of Sussex," gives the following account of the strata of ironstone in the vicinity of Ashburnham. "At Penhurst, near Battel, the soil is gravelly to an indeterminate depth. At the bottom of the Earl of Ashburnham's park, sandstone is found solid enough for building. Advancing up the hill, the sand-rock is twenty-one feet in thickness, but so friable, as easily to be reduced to powder. On this immediately a marl sets on, in the different depths of which the ironstone comes on regularly, in all the various kinds as follows:

"1. Small balls †. Provincially twelve foots, because so many feet distant from the first to the last bed.

"2. Grey limestone, which is used as a flux.

"3. Foxes.

"4. Riggitt.

"5. Balls.

"6. Caballa balls.

"7. Whiteburn: what tripoli, properly calcined and treated, is made of.

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* *Dallaway's History of the Western Division of the County of Sussex*, vol. i. page clxi. folio, 1815.

† The provincial terms employed by Mr. Young are now obsolete; at least I was unable to obtain any explanation of them from the workmen, on a recent visit to Ashburnham.

"8. Clouts.

"9. Pity.

"Advancing on these is a valley, where the mineral bed seems entirely broken, and the sandstone sets on. At the distance of something more than a mile, the ironstone is again seen. Another intervention of sand, and then at low water when the tide goes out, the beds of ironstone appear regularly on the shore. In taking the range northwardly, from the bottom of Ashburnham Park, for twelve miles at least, the strata are nearly the same, there being no material inequality of surface that does not partake of sandstone, marl, ironstone, and sand again at the top. The limestone and ironstone generally rise very near the surface, frequently within three feet. The ironstone, at forty feet below the surface, is not so good as nearer to it, being coarser, and working heavier in the furnace. The very best of the veins are frequently intersected with stripes, the thickness of a quill, filled with a soft marly matter; and the marl beds which the iron lies in, wear a bluer appearance than where it is good. The iron ore, of a dark colour and good quality, is very strongly attracted by the magnet *."

2. LIMESTONE and SHALE, in BLUE CLAY.

The limestone of the iron sand perfectly resembles, both in appearance and composition, the Sussex marble of the Weald, and like that deposit is imbedded in a thick stratum of blue clay; in fact, so striking is the resemblance, that but for the remarkable difference observable in their organic remains, the respective strata, in different parts of their course, could scarcely be distinguished from each other. The limestone under examination is of a light bluish grey, dark blue, yellowish, or reddish brown colour. The upper layers are splintery, and fall to pieces by exposure to the air and moisture; but the lower beds are extremely hard, and form slabs, whose superficial measure frequently equals six or seven feet. It is composed almost entirely of *bivalve* shells, imbedded in a calcareous cement, and is commonly of a sub-crystalline structure. The shells chiefly belong to a species of *tellina;* but they are in too mutilated a state to admit of their characters being correctly determined. This limestone extends from Hastings to near Battel, Ashburnham, Netherfield, Burwash, Rotherfield, and Framfield; and although its outcrop is in many places obscured, or altogether concealed by alluvial deposits, yet there can be no doubt of its continuity beneath the surface, along the tract of country here described. On the estate of the Earl of Ashburnham extensive lime-works have long been established, and previously to the present depressed state of agriculture, were carried on upon a very extended scale. These works are in the centre of Archer's Wood, about two miles from Battel. The limestone is worked by means of shafts, sunk to the depth of from 90 to 120 feet. The following is the order in which the beds ussually occur:

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* *Young's Agricultural Survey*, 8vo. 1808.

1. Loam of an ochraceous or greyish colour, with thin layers of friable shelly limestone.

2. Grey limestone, remarkably firm and compact, composed of bivalve shells, converted into spathose calcareous spar, and held together by a calcareous cement, alternating with grey marl and shale.

3. Compact blue shale and limestone, in alternate layers, from 14 to 20 inches thick, and destitute of organic remains.

The depth of these beds is indeterminate, but exceeds fifty feet. The strata incline towards the south-west, and dip beneath the iron sand of Ashburnham Park.

Mr. Young has given the following admeasurements of the entire series of limestone and shale, exposed by one of the shafts at Archer's Wood; enumerating them according to their order of succession.

		Feet.	Inches.		Feet.	Inches.
Greys. 1.	The first limestone	3	3	Fifth limestone	0	8
	Shale	8	0	Shale	3	0
	Second limestone	0	9	Sixth limestone	0	8
	Shale	9	0	Shale	2	0
	Third limestone	4	0	Seventh limestone	8	3
	Shale	39	0	Shale	4	0
	Fourth limestone	1	1	Eighth limestone	2	0
	Shale	3	0	Shale	1	6

	Feet.	Inches.
Ninth limestone	0	6
Shale - -	0	4
Tenth limestone	0	9
Shale - -	1	3
Eleventh limestone	1	2
Shale - -	0	4
Twelfth limestone	0	8
Shale - -	1	1

	Feet.	Inches.
Thirteenth limestone	1	1
Shale - -	1	6
Fourteenth limestone	0	6
Shale - -	8	0
Fifteenth limestone	2	3

"The last stone is fine enough to set a razor. The Sussex limestone upon trial has been found to be superior both to the Maidstone and Plymouth stone, and it is now acknowledged that no cement equal to it in the kingdom has been discovered. It is the received opinion, that the limestone ranges eight miles from east to west, and one mile from north to south*."

At Terrible Down, six miles and a half north-east from Lewes, the iron sand lies beneath a thick alluvial deposit of loam, sand, and marl, interspersed with thin laminæ of ironstone shale, and rounded fragments of sandstone. These beds extend to Eason's Green †, (where they are succeeded by a dark blue clay, containing shelly limestone, which appears immediately beneath the turf, and is of very considerable thickness. Proceeding northwards, the clay forms a gentle declivity, which is skirted at the bottom by a rivulet: on the opposite side of the stream it swells into a low hill, and terminates in a valley near the ninth mile-stone.

Here the sand and sandstone re-appear at the surface, rising from beneath the clay, and gradually uniting with the higher strata of the Forest ridge, near the Black-boys.

From the absence of natural sections, the relative position of the clay and sandstone is involved in some obscurity; but the former, with its imbedded limestone, is so perfectly analogous to that of Ashburnham above described, that there can be no hesitation in considering them as consecutive deposits. The limestone of Framfield, like that of Ashburnham, Rotherfield, &c. is almost wholly composed of a species of Tellina [*]; it is exposed to view on the side of the road leading from Lewes to the Black-boys, nearly opposite to the ninth mile-stone, and is only occasionally quarried.

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* *Young's Agricultural Survey.*

† Vide Tab. 3, figs. 2 and 3.

It lies but a few feet beneath the surface, and occurs in horizontal strata, divided into thin slabs by layers of blue clay, that contain laminæ of a reddish brown shale, and shells of the same kind as the limestone. In the section (fig. 2. tab. III.) these beds are represented as if lying in a basin or hollow of the iron sand; but subsequent observations have convinced me that this position is incorrect, and that the limestone forms an intervening deposit.

At Isfield, about six miles from Lewes, in sinking the well near the Paper Mill, a layer of bivalve limestone was discovered in a bed of blue clay at the depth of ninety feet. It evidently belongs to the same deposit as that of Framfield, but the shells appear to be of a different species; Mr. Wood (author of General Conchology, &c.) considers them as nearly related to *Tellina cornea*, if, indeed, they are not of the same species.

The geological position of these argillaceous limestone strata is involved in some obscurity. The lowermost beds at Ashburnham are supposed by an eminent geologist [†], to coincide with those of the Purbeck limestone; but at the same time he remarks, "that until they shall have been more scientifically observed, it is impossible to speak with absolute certainty." In the present imperfect state of our knowledge, it may indeed be disputed, whether these beds alternate with the ferruginous sand, (as represented in fig. 3, tab. III.) are situate in a hollow or basin of that deposit, (as in figs. 1 and 2, tab. III.) or form a protrusion or hillock of the Purbeck lime-stone, as in the annexed diagram.

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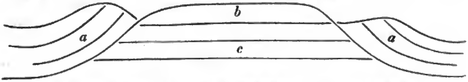
[*] Mr. G. B. Sowerby, author of "The Genera of Recent and Fossil Shells," kindly obliged me by an examination of the shells contained in the Framfield limestone. The general appearance of some of the specimens he thought resembled the *Nuculæ*, but other circumstances led him to consider it probable that they might belong to the genus *Cyrènè*; the important question whether they are of marine, or of fresh water origin, is therefore still undecided.

[†] Rev. W. Conybeare, in Phillips' Geological Outlines, &c.



a. a. Iron sand. *b.* Shelly limestone. *c.* Purbeck beds.

§ 3. COAL. At Newick Park, Waldron, and Bexhill, seams of fibrous coal resembling that of Bovey, have been discovered; but the thickness and extent of the beds have not been correctly ascertained. To Mr. Cater Rand of Lewes, I am indebted for the following section of the strata at Newick.

SECTION OF THE STRATA IN NEWICK OLD PARK,

situate one mile from the banks of the Lewes Canal.

1. Vegetable earth and sand.
2. Sandstone and clay.
3. Sandstone and indurated marl.
4. Shivery sandstone and clay.
5. Indurated clay rubble.
6. Sandstone and blue clay alternating.
7. Strong bind.
8. Coal of the Bovey kind, examined only to the depth of eleven inches; it bassets out on the side of a rivulet, and may also be observed in the bank of the adjoining hop grounds. Several bushels of coal were dug up. The strata have a slight inclination W. N. W.

The Newick coal in my possession has very much the character of jet: it is of a velvet black, does not soil the fingers, has a resinous lustre, and a conchoidal fracture; is very brittle, and burns with a bright flame.

At Bexhill, the south-eastern extremity of the Forest-ridge towards the sea, indications of coal induced some enterprising individuals to sink a shaft, and at the depth of 160 feet, a bed of coal of good quality, was discovered; but unfortunately the works were suddenly inundated by a vast body of water, and the undertaking was finally abandoned.

It appears that the enterprise originated from the suggestions of a Mr. James, who was sent to Bexhill in 1804, to survey the estates of the Duke of Dorset. This gentleman perceiving some resemblance between the strata exposed by the wells at Bexhill Barracks, and those which occur at Bovey, imagined that a bed of coal might be found at the depth of about sixty yards. In consequence of this idea, a company of adventurers was soon formed, and the requisite operations were carried on in a close near the sea-shore.

I have to offer my acknowledgements to Mr. Rand, for the following account of the beds passed through on that occasion.

SECTION OF STRATA AT BEXHILL,
explored in a search for coal, in 1804—9.

		Yards.	Feet.	Inches.
Sunk.	Soil, clay, and sandy loam	3	0	0
	Dark Clunch	3	0	0
	White rock with kind partings	3	0	0
Bored.	Do. Do.	1	1	0
	Dark Clunch	1	0	0
	Grey Rock	1	2	0
	Dark Clunch	1	0	0
	Strong grey rock	1	2	6
	Blue binds	1	0	6
	Grey rock with kind partings	6	0	0
	Blue bind	1	0	6
	Stone grey rock	1	0	0
	Blue bind	0	2	7
	Strong white rock	1	1	4
	Dark Clunch	2	1	9
	Smut Coal	0	2	3
	Grey bind	4	2	3
	Blue bind with iron ore	3	1	9
	White stone	1	0	0
	Clunch, or fire clay	1	0	2
	White sandstone	1	2	9
	Kind clunch parting	0	0	8
	Brown sandy rock	0	2	9
	Sharp peldron	3	0	0

	Yards.	Feet.	Inches.
Blue bind - - -	1	2	0
Strong brown rock	1	1	0
Blue-bind, containing impressions of fern leaves - -	2	1	6
Blue-bind with iron ore - - - - -	0	2	0
STRONG COAL -	1	0	6
Yards	54	1	9

The borings were continued, but no account remains of the nature or depth of the strata: mention is made of a second bed of *coal* four feet six inches thick, the coal of bad quality, and very sulphureous. Salt-water oozed through the divisions of the beds, and although an engine of eighty horse power was employed, the works were completely inundated.

I have not seen any specimens of the Bexhill coal, but according to Mr. Rand, it resembled that of Newick. It is not a little curious, that research for coal in so improbable a situation, should have been attended with the slightest indication of such a substance; since if in the present infancy of geological science, we may venture to draw any general conclusions from established facts, there was every reason to suppose, that such an attempt must have proved abortive.

At Waldron, a thin bed of cannel coal has been noticed on the banks of a rivulet which separates that parish from Heathfield; but it has not been examined with any degree of attention. It is stated to occur in beds of a few inches thick, that extend for a quarter of a mile immediately beneath the surface, at the bottom of Geer's wood.

ORGANIC REMAINS.

The organic remains discovered in the strata above described, are few and unimportant. The *bivalves* of the limestone; the *impressions of ferns* in the sandstone of Bexhill and Hastings; and the fragments of *lignite* in that of Horsted, being the only extraneous fossils that have been observed.

In other parts of England, the Iron sand contains nautili, ammonites, belemnites, ostreæ, terebratulæ, and numerous varieties of spongitæ, and other zoophytes*; but of these no traces exist in the sand of Sussex.

VI.

§ 1, 2. LIMESTONE OF TILGATE FOREST.

THE strata that form the subject of the following observations possess a high degree of interest, and constitute one of the most important series of deposits in this part of the kingdom. The nature and variety of their organic remains, and the general resemblance which they bear to those of the Purbeck limestone, and Stonesfield slate, have led me to an assiduous investigation of their history.

I have however to regret, that the distance of my abode from the tract of country in which they are situated, has presented serious obstacles to an accurate determination of their geographical dimensions; but I have spared neither pains nor expense to obtain a general knowledge of their fossil remains, and geological relations.

As these strata are of inconsiderable extent, and hold an intermediate situation between the Iron sand and the Weald clay, appearing to repose upon the former, it seems probable, that they are either a local deposition, formed in an excavation, or basin, of that deposit; or a protrusion of the Purbeck beds, which lie beneath it. Without however, deciding in favour of either supposition, it has been thought expedient to describe these strata in a separate section; and for the present, to distinguish them by a term derived from the central locality of the area they occupy on the surface.

The strata of Tilgate forest consist of various layers of sandstone, limestone, and calcareous slate, lying on a bed of blue clay, of very considerable thickness. Advancing from the Downs, on the Brighton road, the outcrop of the sandstone is first seen near Taylor's bridge; and it subsequently appears on the margin of the stream that winds along the foot of Cuckfield park, a quarter of a mile south of the town. At this spot an excavation has been made, which exposes to view a perpendicular rock of sandstone about twenty feet high; the strata are nearly horizontal, and vary from one to five feet in thickness.

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* *Phillips' Outlines*, page 140.

The hill, on the southern slope of which the town of Cuckfield is situated, is also composed of this formation, and in a field adjoining the church-yard, the sandstone is seen lying beneath a thick layer of diluvial aggregate, and containing subordinate beds of limestone.

From the cultivated state of the country, and the quantity of loam and vegetable soil, I have been unable to trace the outcrop of these deposits with the requisite degree of accuracy. In a northerly direction they extend from Cuckfield through Handcross, and Tilgate forest, to Crawley, and on the north-west probably as far 'as Horsham, and St. Leonard's forest; eastward I have not noticed them beyond the vicinity of Lindfield; but it must be acknowledged that from the causes already mentioned, their geographical extent is but imperfectly known.

On the line of road extending from Hicksted to Crawley, several quarries have been opened for obtaining the stone for architectural and other economical purposes, and in these excavations the strata may be examined with facility.

In the sections that were accessible to observation, some variations were noticed in the composition and relation of the beds; but these were neither constant, nor important; and the entire series is readily identified by the extraordinary character of its organic remains.

The following section is the result of numerous observations, and may be regarded as the order in which they generally occur; commencing with the lowermost deposit.

SECTION OF THE STRATA OF TILGATE FOREST.

1. Blue tenacious clay destitute of organic remains, and of an indeter-

minate depth. In this bed water occurs at the depth of thirty or forty feet.

2. Compact limestone, of a bluish grey colour, separated by seams of indurated blue marl, into layers, from three to twelve inches in thickness. It forms a bed about nine feet thick, and contains the bones of two species of turtle, of one or more species of crocodile, or monitor; and the remains of vegetables allied to the euphorbiæ. The upper strata are a compact conglomerate; the lower are perfectly homogeneous, and where in contact with the clay, contain shells of the genus vivipara.

3. Yellowish sand, and soft calcareous sandstone, alternating with thin layers of compact limestone slate; containing bones of crocodiles, of some unknown animals, and of birds; bones and plates of two species of tortoises; carbonized wood; remains of vegetables resembling the euphorbiæ, arborescent ferns, gigantic reeds; and casts of univalves and bivalves, &c. This bed is about seven feet thick.

4. Diluvial aggregate, composed of quartz pebbles, and rounded fragments of chalk, limestone, and sandstone, loosely united by a coarse grit; it contains immense quantities of minute portions of bone rounded by attrition, teeth of fishes, and of lacertæ. Thickness from three to six feet.

5. Vegetable mould and loam, from one to three feet thick.

Total thickness of the beds above the clay, about twenty-five feet.

In this enumeration of the strata, those fossils only are mentioned, which appear to occur most frequently in the respective beds, since the organic remains are distributed indiscriminately throughout the whole series of deposits, although certain of them are more abundant in one stratum, than in another.

The limestone (No. 1.) is exceedingly compact, and offers great resistance to the hammer; it scintillates with steel, effervesces strongly with acids, and varies considerably in purity. The upper part of the rock is a conglomerate of a mottled appearance, exhibiting various shades of blue, white, and greyish green. It is composed of quartz pebbles and irregular fragments of limestone and bones, imbedded in a calcareous gangue; and is interspersed with crystallized carbonate of lime. The quartz pebbles appear to be of chemical origin, and not derived from the ruin of other strata. The intermediate layers are a pure bluish grey, or greenish limestone, in texture and appearance very much resembling the finer beds of the Swindon stone*.

The inferior layers are very analogous to the Purbeck limestone, and where in contact with the clay, contain remains of the same kinds of testaceæ.

The bed is traversed by thin veins of calcareous spar of a light amber colour; and this substance generally occupies the fissures in the wood, bones, and other organic remains, forming groups of tabular, and lenticular crystals in the cavities of the limestone. It also contains small nodular masses of carbon, and charred wood. Every kind of fossil that has been discovered in the strata of Tilgate forest, occurs in this bed, viz. bones and teeth of the gigantic monitor or crocodile; bones and plates of turtles; teeth of fishes; leaves and stems of euphorbiæ; casts of univalves and bivalves, &c.

The sand and sandstone, (No. 3,) vary from a light fawn colour to a deep brown, and in some parts are highly ferruginous. The sandstone is soft and friable, and alternates with thin layers of calcareous slate. The latter is compact, but readily separates into thin flakes, and these are divided by the workmen into slabs, from one, to a foot and a half square, which are used for roofing in that part of the country. The surface of this slate presents a most extraordinary appearance, being every where marked with undulating furrows, so strikingly resembling the impressions made on the sand of the sea shore, by the action of the waves, that I cannot but regard them as the result of a similar operation.

The sandstone contains the teeth, vertebræ, and bones of the crocodile, and large portions of the stems of vegetables allied to the euphorbiæ and dicksoniæ; besides others, which are in too imperfect a state to admit of their characters being determined. The slate abounds with the carbonized foliage of unknown plants, carbonized wood, and casts of univalves and bivalves. Carbonate of lime in lenticular crystals sometimes occurs between the separations of the strata, and rounded quartz pebbles in the blocks of sandstone.

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* Swindon, near Marlborough, Wilts; the stone quarried in its vicinity is a member of the Portland limestone.

The aggregate (No. 2.) is evidently diluvial; it lies in horizontal layers, immediately beneath the vegetable mould, and varies from one to six feet in thickness. It is of considerable extent, and there is scarcely any inequality of the surface, in the immediate vicinity of Hicksted, Crawley, &c., where it is not exposed to view. In the upper part of the bed, the chalk, limestone, sandstone, and quartz pebbles, are reduced to the size of small grains; and the bones, teeth, and other organic remains, have suffered an equal degree of comminution; in the inferior layers they are considerably larger, and the chalk and quartz pebbles less frequent.

The chalk appears to have undergone but little change, except that it has acquired considerable hardness, probably from an infiltration of crystallized carbonate of lime.

The quartz pebbles exhibit their usual characters; they are slightly translucent, and being rubbed against each other, emit a strong electric smell, with a stream of light at the line of collision. This accumulation of water-worn materials is loosely united by a fine grit, apparently formed by the farther disintegration of the same substances. The organic remains contained in it are, with but few exceptions, reduced to very small fragments, which offer but slight indications of their original form. The teeth and scales are the most perfect, their superior hardness having enabled them in some measure to resist the action of the water. Of these, the molar teeth of the anarhicas lupus, are the most abundant. The teeth and scales of the monitor or crocodile, and the bones and plates of a species of tortoise, are occasionally found in it; and also the triangular striated tooth, (No. 14.) and the teeth of a species of squalus, (No. 13.)

We shall now proceed to a more minute examination of the organic remains of these remarkable strata; and by comparing them with the recent genera, and species, to which they appear most nearly related, endeavour to obtain some idea of the form, and structure, of the originals.

ORGANIC REMAINS OF THE STRATA OF TILGATE FOREST*.

VEGETABLE REMAINS.—These occur either in the form of carbonaceous impressions in the limestone slate and carstone; or consist of sandstone casts of a ferruginous colour, bearing the form and external characters of the original.

1. *Wood.* In the state of carbon or charcoal, still retaining its ligneous structure. The fissures in its substance are filled, in some specimens, with white calcareous spar, and in others, with pyrites of a brilliant appearance; the latter quickly undergo decomposition by exposure to the air.

It occurs in small portions, which are generally imbedded in the more compact masses of carstone.

2. The stems or culms of vegetables allied to the euphorbiæ, or to some species of arborescent fern; perhaps *Dicksonia?*

The surface of these fossils is rough, being covered with oblong irregular tubercles, disposed in longitudinal undulating lines. The trunk is nearly cylindrical, but somewhat compressed, and is contracted at irregular intervals; in some specimens exhibiting rudiments of branches. The largest are nearly fourteen inches in circumference, and upwards of four feet in length†; and from the imperfect state in which these occur, it is evident that the originals attained a very large size: sections show no traces of the internal structure. They are associated with impressions of leaves and other vegetal remains, but my distance from the quarry has prevented me from ascertaining the relation they bear to each other.

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* When the idea of this work first suggested itself, my information concerning these deposits was too imperfect for publication, and their description was in consequence excluded from the original plan. The organic remains I then possessed were but few and uninteresting, and the plates were devoted to other objects before more illustrative specimens occurred. Should circumstances permit, I shall hereafter lay before the public, delineations of several extraordinary fossils recently discovered in these strata.

† One of the finest specimens hitherto discovered is deposited in the British Museum.

They are principally found in the sand and sandstone, and are covered with a ferrugino-carbonaceous crust, which falls off when the surrounding matrix is removed.

I am unacquainted with any vegetables, either recent or fossil, with which these remains can be identified. They bear some analogy to the *Phitolithus plantites verrucosus* of Marten[*], but differ in the superficial markings, and are destitute of the imbricated body observable in the Derbyshire fossil. They agree in their general conformation with the euphorbiæ of the East Indies, but at the same time, present differences sufficiently remarkable to prove their want of identity. In all probability they are casts formed in the cavities of the stems of arundinaceous plants, the crust with which they are invested, being the remains of the cortical covering of the original.

3. A cylindrical imbricated body, marked with interrupted longitudinal striæ—the medullary or internal part of a vegetable, analogous to the fossils last described. It is composed of sandstone, and occurs in fragments of a foot or more in length, and from six to eight inches in circumference.

4. A hollow cylindrical body, slightly compressed; the cortical or epidermal remains of a vegetable.

This fossil is two inches and a half long, twelve inches in circumference, and one inch in thickness. The external surface is divided into compartments of a rhomboidal form, by deep cancellated sulci, and the internal is marked with interrupted longitudinal striæ, apparently the impressions of a body which it formerly enclosed. This specimen is decidedly the remains of the epidermal covering of a plant, and, very probably, of the same kind as the fossil, No. 3, the markings on the external surface of the one, and the impressions on the interior of the other, perfectly corresponding. In its structure it approaches to *Plantites verrucosus* of Marten, but its external surface more nearly resembles that of *Phitolithus plantites imbricatus*[†]; it is, however, essentially distinct from either. It is probably part of an unknown species of palm, or arborescent fern: Mr. Konig observes, that "some arborescent Dicksonias are very like it with regard to the lozenge-shaped bases of the fronds, or leaves."

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[*] *Petrificata Derbiensia; or, Figures and Descriptions of Petrifactions, collected in Derbyshire, by William Marten, F.L.S. Wigan*, 1809. Tab. 11, 12, 13.

[†] *Petrificata Derbiensia*, Tab. 14, fig. 5, and Tab. 50.

This specimen is from the sandstone, and is the only one hitherto discovered *.

5. A compressed clavated culm or stem of a plant, the surface possessing a leafy structure, and having numerous tortuous sinuses, that pass into the substance of the fossil: a transverse section, three inches in diameter, exposed thirty-five openings produced by this cause.

These fossils occur in fragments from a few inches, to several feet in length, and some of them attain a considerable magnitude, being upwards of two feet in circumference. They are of an irregular club-like form, having a very narrow base, and are invested with a thick carbonaceous covering, removable by washing. Their constituent substance is a hard limestone, of a light ash colour, interspersed with drusy crystals of carbonate of lime. They are found associated with the fossil vegetables, previously noticed, but are of more rare occurrence. The internal structure of these petrifactions resembles that of many succulent plants, and in their outward form they so nearly approach the euphorbiæ, that it may be presumed they are the remains either of an unknown species of that genus, or of one very closely allied to it.

6. Impressions and remains of the foliage of unknown vegetables, in a carbonized state, lying in confused masses in the car-stone and limestone shale.

So far as their form can be distinguished, some of the leaves appear to be of an ovate, and others of a lineari-lanceolate shape; but they are too imperfectly displayed to admit of accurate determination. In some respects they resemble the foliage of the Derbyshire phytolite, *Pet. Derb.* Tab. 12; and as they are associated with the supposed euphorbiæ, it seems probable that the stems of the latter were furnished with leaves, of which these are the remains.

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* Subsequent observations have convinced me that this specimen is decidedly the epidermal covering of Nos. 2 and 3, the latter being the casts of the internal part of the original.

7. The impressions of leaves, of a species of *carex* or sedge; perhaps iris?

These are frequent in the form of reddish brown stains, and impressions; similar remains also occur in the Stonesfield slate[*].

FOSSIL SHELLS.

These, with but one exception, occur only in the state of casts or impressions; and their characters are so imperfectly defined, that it is scarcely possible to ascertain the genera and species to which they belong.

8. Vivipara *fluviorum?* perhaps *Paludinæ?*

These are apparently similar to the shells of the Petworth marble, figured in tab. XVII. figs. 5, 6. They occupy the lowermost layers of the car-stone, and occur in groups of fifty or sixty, disposed in relief on the surface of the stone, where the latter is in contact with the blue clay.

9. Vivipara *extensa*, associated with the former.

10. Casts of spiral univalves, of uncertain genera.

11. Casts of two species of mya or unio.

12. Casts of four species of transverse bivalves, whose generic characters cannot be determined. Some parts of the limestone contain a considerable number of these nuclei, closely invested by the surrounding matrix, no appearance of the space formerly occupied by the shells being perceptible[†]. The surface of the casts is smooth, and of a ferruginous colour, spotted with stellular markings of a darker shade.

REMAINS OF FISHES.

The teeth, and perhaps the scales, are the only parts of fishes that have been found in these deposits. The former, from their hardness and durability, are in an excellent state of preservation, retaining their original sharpness of outline, with their natural polish, heightened and improved by mineralization. Their colour is a dark chocolate, inclining to black, apparently produced by an impregnation with oxide of iron: they are exceeding brittle, and have their cavities filled with the substance in which they are imbedded.

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[*] It is worthy of remark, that with the exception of fragments of charred wood, the vegetal reliquiæ of the Tilgate limestone and sandstone, consist exclusively of those which possess the most simple structure, viz. the monocotyledonous, or acotyledonous tribes of plants.

[†] This mode of petrifaction is termed redintegration. Vide page 50, *Martin's Outlines of an Attempt to establish a Knowledge of extraneous Fossils on scientific Principles*, 8vo. 1809. Macclesfield.

13. A triangular tooth, of a species of Squalus or shark, resembling in form the specimen represented, fig. 9. pl. xix. vol. iii. Org. Rem. but much smaller: it occurs also at Stonesfield, near Oxford.

14. A triangular tooth, with two lateral processes, the surface longitudinally striated—length 0·2 inch. Mr. Parkinson has figured a similar fossil from the Old Passage, Gloucestershire, but does not offer any opinion as to what animal it originally belonged.

15. Molar teeth of the Anarhicas *lupus*[*]. These are of a semi-orbicular form, sometimes slightly acuminated, from the size of a millet seed to 0·5 or 0·6 inch in diameter: they possess a beautiful polish, and are called "fishes eyes" by the workmen. I have compared these fossils with the molar teeth of the recent A. lupus or sea wolf, and could not perceive the slightest difference either in their form or structure. They are frequently worn nearly flat, probably from the mastication of hard substances, as the recent fish preys on crustaceous and testaceous animals. In one specimen twenty of these bodies are attached to a small block of limestone. They are very abundant in the alluvial aggregate, and are found in the Stonesfield slate.

16. Scales of a lozenge shape, an inch long, and three-quarters of an inch wide, having bifurcated processes of attachment.

These scales are very thick, and of a glossy black colour; the process of attachment is of a pale brown, and of a bony, or perhaps, cartilaginous structure. Although in conformity with the opinion of others, I have been induced to consider these fossils as belonging to an unknown fish; yet I entertain some doubts if they may not, with greater propriety, be referred to an animal of the lizard tribe.

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[*] Vide *Parkinson, Org. Rem.* vol. 3. xix. fig. 6, 7. *Lhywd*, fig. 1382. 1525. *Scilla, Tav.* 2. *Faujas. Hist. St. Pierre*, tab. xix.

REMAINS OF OVIPAROUS QUADRUPEDS.

These consist of the bones, and plates, of several species of tortoise; and the scales, teeth, vertebræ, and other bones, of one or more species of crocodile.

FOSSIL TORTOISES.

The remains of these animals in my possession, clearly point out the existence of three species in the Tilgate beds. The first, in the form of its plates, resembles the *Testudo mydas* (esculent green turtle) of Linnè, (*testudo viridis* of Schneider), and must either have belonged to the same species, or to one very analogous to it. Of this kind I have the following specimens.

17. Three detached plates on a block of car-stone, resembling the plates on the left side of the tortoise of St. Peter's mountain. (*Faujas*, Pl. XIV.) Two of these are mutilated, but the other is nearly perfect; it is of a quadrangular form, measuring 2·4 by 2·7 inch. and its edges are slightly dentated.

18. A specimen six inches long, and two wide, composed of three united dorsal plates.

19. Dorsal plates with rudiments of the ribs.

These fossils are evidently of the same species as the turtles found at Melsbroeck. It may be proper to remark, that the recent species abovementioned, is an inhabitant of the coasts of the islands, and continents of the torrid zone.

20. Of the second species of testudo, I have but a few imperfect plates, yet their structure is so well displayed, as to leave no doubt of their being distinct from those previously described. Their surface is covered with numerous little pits or hollows, irregularly disposed, and which served in the recent state, to render the soft integument of the animal more adherent. The specimens in my possession resemble the plate from the Paris basin (fig. 1. *Fossiles de Paris, reptiles et poissons*) described by Cuvier, and referred by that illustrious naturalist to the subgenus *Trionyx* of M. Geoffroy; a division that contains fresh water species only.

21. The existence of a third species is presumed, from a plate, to which a portion of the rib is still attached. Mr. Clift of the Royal College of Surgeons, who did me the favor to compare it with the recent turtles in the Museum of the College, remarks that "this fossil resembles the third rib from the neck, of a species allied to the hawk's-bill turtle," (*testudo imbricata*) which inhabits the American, and Asiatic oceans. The rib is longitudinally striated, and precisely similar to the specimen from Melsbroeck, fig. E. Planche V. of Burtin [*].

Of the bones of the testudines, I have obtained the following, and probably several others, which at present I am unable to distinguish from those of other animals.

22. Part of the Omoplate or scapula. Cuvier, Tome IV. Pl. 2. 5. *b*.

23. . . . . clavicle. Cuvier, Tome IV. Pl. 2. 5. *d*.

My excellent friend Mr. Lyell, informs me, that the remains of several species of testudo have been discovered at Stonesfield; and that some of the plates which he saw, resembled the first species above enumerated; the circumstance is mentioned here, to point out the remarkable correspondence that exists in the contents of these deposits.

FOSSIL LACERTÆ.

The teeth, vertebræ, bones, and other remains of an animal of the lizard tribe, of enormous magnitude, are perhaps the most interesting fossils that have been discovered in the county of Sussex.

The teeth and scales, like those of the fishes, are generally well preserved, but the bones have sustained considerable injury from fracture and attrition, which renders the determination of their osteological characters exceedingly difficult. Of the numerous specimens in my collection, not one is perfect; by far the greater part consisting of fragments rounded by the action of water, and deprived of those anatomical distinctions so essentially necessary to the elucidation of the form of the original. They are heavy, brittle, of a deep brown colour, and strongly impregnated with iron; and when exposed to the action of the blow-pipe, evince unequivocal proofs of their animal origin. Their cellular structure is sometimes beautifully displayed, being injected either with limestone, or crystallized carbonate of lime; and in numerous specimens the medullary cavities of the long bones are filled with white semi-transparent calcareous spar. The vertebræ are the most entire, but even these have their bodies more or less compressed, and their processes broken, or altogether destroyed. But notwithstanding the mutilation these remains have undergone, their osteological characters are still sufficiently marked, to denote not only the genus of the animal to which they belonged, but also to afford some slight indication of its species.

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[*] *Oryctographie de Bruxelles, ou Description des Fossiles tant naturels qu' accidentels decouverts jusqu'a ce Jour dans les Environs de cette Ville, par M. François Xavier Burtin.* Folio, 1784.

The following are the most illustrative specimens in my possession, and from which the suggestions hereafter offered concerning the nature of the original, are principally derived.

24. Teeth of a conical form, slightly curved, their surface covered with numerous longitudinal ridges or striæ, which converge towards the apex: the superior terminations are acuminated in some examples, and rounded or obtuse in others.

These fossils are either round, or somewhat compressed, and vary considerably in size and curvature; they are from 0·2 inch to 3 inches long, and from 0·3 inch to 2·8 inches in circumference at the base; the upper part only is striated, the lowermost half being perfectly smooth. With but few exceptions they consist of the crown of the tooth only, appearing as if broken off close to the jaw; and although in a few instances part of the fang remains, yet the detached state in which they are found, prevents their mode of insertion from being accurately determined. The fangs are hollow like those of the crocodile, but the presence of younger teeth within the cavities of the older ones, as in that animal, has not been detected *.

The teeth possessing the characters here enumerated, constitute the following varieties, but whether they originally occupied different situations

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* In a specimen recently discovered, this structure is however very apparent.

in the jaws of the same species, or belonged to different species of the same genus, cannot at present be determined.

var. a. Nearly cylindrical; diminishing very gradually towards the apex, which is obtuse. This variety is represented by Lhwyd, figs. 1318 and 1319; the largest specimens are of this kind.

var. b. A slender delicate tooth, rather compressed, curvature gradual, apex slightly acuminated; Mr. Clift, who examined a tooth of this species, observes "that there can be no doubt of its having belonged either to the crocodile, or monitor; I know of no other animals whose teeth have the lateral ridges so strongly defined." I have several teeth of this kind from Stonesfield, collected by Mr. Lyell.

var. c. A slender tooth, nearly straight; very similar in form to the teeth in the anterior part of the jaw of the Gavial or Gangetic crocodile*.

25. Scales of an irregular rhomboidal form, exceedingly thick, with one extremity sharply pointed; these are associated with the teeth above described, and perfectly resemble the scales of the recent alligator in Exeter 'Change.

VERTEBRÆ.

These differ from each other in the number, situation, and form of their processes, which vary according to the situation the vertebræ respectively occupied in the spinal column. In their general characters they resemble those of the crocodile, from which however they are separated, in having both faces slightly concave. A similar structure has been noticed by Cuvier, in the vertebræ of an unknown fossil crocodile, discovered at Havre and Honfleur; and it is to this species that the osseous remains of the Tilgate beds most nearly correspond.

The vertebræ are of three kinds, viz. *dorsal, lumbar*, and *caudal;* the *cervical* have not been discovered.

26. * *Dorsal.* The most perfect specimen resembles the vertebræ delineated by Lhwyd, fig. 1607, and fig. 11. Pl. I†. of Cuvier; or more

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* On the authority of —— Clift, Esq.

† *Description des Ossemens des Environs d'Honfleur et du Havre. Cuvier, Animaux Fossiles, tome IV. Crocodiles Fossiles.*

properly speaking, partakes of the characters of both. The body is slightly contracted in the middle, and has two costal depressions, or concave articulating surfaces for receiving the heads of the ribs, (*faucette costale, a. b.* Cuvier, loc. cit.) between which are two fossæ, each containing a foramen; the faces are transversely elliptical. The dimensions of the vertebræ are as follow:

Length of the body, 1·5 inch.
Transverse diameter of the faces, 2 inches.
Anterio-posterior diameter, 1·5 inch.

The processes are wanting; but traces of the suture by which the annular part was united to the body of the vertebræ, are very manifest.

27. [b] *Lumbar.* These resemble the former, except that the costal depressions are absent; they are of a large size, and must have belonged to an animal of considerable magnitude. One specimen, which is precisely similar in form to the middle vertebræ, in fig. 6, Crocodiles Fossiles, Pl. I. of Cuvier, (except that both its faces are slightly concave,) is of the following dimensions:

Length of the body, 5 inches.
Diameter of the faces, 3·8 inches.
Diameter of the middle, 2·8 inches.

Like the vertebræ described by Cuvier, this specimen is more contracted in the middle than those of the recent crocodile, and it also resembles the former, in having a deep fossa immediately beneath the annular part. (*Vide d.* fig. 10. Cuvier, loc. cit.)

28. [c] *Caudal.* In these the axis of the body is much contracted; they are of an elongated form, and bear a close analogy to the vertebræ of the recent crocodile, (fig. 7. Pl. II. Os séparés de Crocodiles, Cuvier.) One of the most interesting specimens[*] in my possession has the remains of the spinous and articulating processes.

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[*] This fossil was submitted to the inspection of Mr. Clift, who remarked, that it perfectly resembled the vertebra of a crocodile, except that both its extremities were concave, while those of the recent animals of that genus were concave anteriorly and convex posteriorly.

Length of the body, 3 inches.

Diameter of the middle, 1·2 inches.

Diameter of the faces, 1·4 inches.

The agreement between the vertebræ here described, and those of the fossil crocodile of Honfleur[*], is so striking, as to leave no doubt in my mind of their identity. This opinion is confirmed by the nature of the other bones entombed in the same deposit, and which we shall now proceed to examine.

Of these remains the *ribs* are the most perfect, and their osteological characters are decidedly analogous to those of the lizard tribe. The following are selected as the most illustrative examples.

29. Part of a rib, with the vertebral extremity remaining. The head of the rib, and the tubercle by which it was attached to the transverse process of the vertebræ, are broken off, but the situation of these parts is

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[*] Two species of crocodile are found in a fossil state at Havre and Honfleur; one having its vertebræ concavo-convex, as in the recent species, and the other with both faces of the vertebræ slightly concave. It is to the latter, that the bones in question are referable; a species that Cuvier considers as extinct, but which is nearly related to the Gavial or Gangetic crocodile. These organic remains also correspond with those of the Tilgate strata in their mode of preservation, but the bed in which they are deposited, (and which I had formerly imagined might be identified with our Weald clay,) is referred by Mr. Parkinson, to the Blue Lias of Dorsetshire. It may not be uninteresting to add Cuvier's description of the strata.

After a few prefatory observations, this illustrious naturalist thus proceeds:

"Ils sont tous dans un banc de marne calcaire endurcie, d'un gris bleuâtre, qui devient presque noirâtre quand il est humide, et qui règne des deux côtés de l'embouchure de la Seine, le long du rivage du pays de *Caux* et de celui du pays d'Auge, comme au cap de la *Hève*, et entre *Touque* et *Dives*, vis-à-vis les *Vaches-noires*.

"Il s'élève en quelques endroits au-dessus du niveau des plus hautes marées, et dans d'autres il est recouvert par les eaux de la mer. Il récèle partout des huîtres, de petites moules, et de petites tellines discoïdes d'espèces particulières, et les os eux-mêmes ont des huîtres et des tuyeaux de serpules adhérens à leur surface; mais il n'est pas aisé de dire si ces coquilles y tenoient déjà avant qu'ils eussent été enveloppés par la marne, ou si elles ne s'y sont attachées que depuis que la mer les a lavés et mis à découvert.

"Quant à ce banc de marne, il est certainement plus ancien que la masse immense de craie qui repose sur lui, et qui s'élevant en falaises de 3 et 400 pieds de hauteur, forme tout le pays de *Caux*, une partie du pays d'*Auge*, et s'étend en *Picardie*, en *Champagne*, et jusqu'en *Angleterre*.

"La substance des os est d'un brun très-foncé, et prend un beau poli; les acides la dissolvent et en prennent une teinte rougeâtre, qui annonce qu'elle est colorée par la fer. Elle a cependant conservé une partie de sa nature animale." *Cuvier, Animaux Fossiles, Tome IV. Crocodiles Fossiles*, p. 17, 18.

sufficiently indicated, to prove the resemblance of the specimen to the vertebral end of the ribs of the crocodile, Pl. 2, fig. 4. *k. i.* *Os séparés de Crocodiles. Cuvier, Tome* iv.

30. A rib twenty-one inches long, with both extremities destroyed. The sternal end is transversely elliptical, and about two inches in circumference; the bone gradually increases in width towards the opposite extremity, where its inner surface becomes nearly flat, and the outer slightly ridged; the width of this portion is equal to the circumference of the sternal end. Fragments of ribs of this kind occur also at Stonesfield.

From the mutilated state of the following specimens, the references to Cuvier's figures of the bones of the recent crocodile, are probably in some instances erroneous; they may, however, for the most part, be regarded as nearly approximating to correctness.

31. Portion of the sternal end of the clavicle? fig. 10, Pl. 2. (*Os séparés de Crocodiles. Cuvier, Tom. iv.*)

32. Head of the radius? *b*, fig. 13, Pl. 2.

33. Carpal extremity of the radius? *b*, fig. 13, Pl. 2.

34. Part of the os pubis? *c*, fig. 15, Pl. 2.

35. Fragment of the os ilium? *a*, fig. 15, Pl. 2.

36. Lower extremity of the femur? *B*, fig. 12, Pl. 2.

37. Some fragments of a cylindrical bone, probably the femur, indicate an animal of a gigantic magnitude. I have specimens from ten to twenty-seven inches long, and from eleven to twenty-five inches in circumference; the substance of the bone being more than two inches thick; some examples have large foramina for the passage of blood-vessels*.

38. Lower extremity, and other portions of the tibia? fig. 11, Pl. 2.

39. Fragments of the metatarsal bones? fig. 16, Pl. 2.

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* I may perhaps be accused of indulging in the marvellous, if I venture to state, that upon comparing the larger bones of the Sussex monitor with those of the elephant, there seems reason to suppose, that the former must have more than equalled the latter in bulk, and have exceeded thirty feet in length! and yet some fragments of bone in my possession, warrant such a conclusion.

From the facts that have been presented to our notice, we may with confidence conclude, that the remains in question belonged to an animal, approaching in its osteological characters to the crocodile, (or perhaps to the genus Monitor of Cuvier,) but differing in many important particulars from the recent species: that they are precisely similar to the bones of the second species of fossil crocodile discovered at Honfleur, and which Cuvier considers as an extinct animal, related to the Gavial or Gangetic crocodile; lastly, that this species exceeded in magnitude every animal of the lizard tribe hitherto discovered either in a recent or fossil state.

TEETH AND BONES OF UNKNOWN ANIMALS.

Associated with the remains of the monitor and turtles above described, are several teeth and bones, whose characters are too obscure and uncertain to admit of determination, without the aid of more illustrative specimens. A brief description of these fossils is here inserted, not in the hope of being able to elucidate their nature, but to record their existence in the Tilgate beds with a view to future inquiries.

40. *Teeth.* Among these are several incisors and molares that have evidently belonged to the same kind of animal; they are of a very singular character, and differ from any previously known. The molares are of an irregular pentagonal form, their sides channelled and obscurely striated. The masticating surface is perfectly smooth, and rather depressed in the centre, and in the largest specimen is 0·8 inch long, and 0·5 wide. They consist of the crown of the tooth only, and are perfectly solid.

An incisor tooth that appears to correspond with the preceding, is 1·3 inch long; it is slightly bowed, and nearly smooth on the inner surface, but externally has a longitudinal ridge which extends down the front. The crown of the tooth is 0·6 inch long, and 0·4 inch wide; its sides are angular, and their edges finely crenated.

41. An incisor tooth of a cuneiform shape, 1·1 inch wide, and 1·4 inch long; the crown only remains.

When perfect, this specimen must have been of a very considerable size;—several smaller examples were discovered by Mrs. Mantell in the diluvial aggregate.

42. A curved tooth much compressed, the surface smooth, the apex obtuse, and the edges serrated. The external margin is thick and rounded, the inner edge thin and acute; length 1·5 inch.

This specimen resembles fig. 1328 of Lhwyd, but does not entirely correspond with the figure of that author; a reference to it will however serve to render this description more intelligible. "The teeth near the front of the lower jaw of the *barracouta*, are very similar in form*."

43. Part of the scale of a fish? it is half an inch square, and its surface covered with irregular depressions. "The markings on its surface resemble those of the dorsal scales of the sturgeon†." (Accipenser sturio.) May it not have belonged to a species of trionyx?

44. Part of the lower jaw of a fish? (or of an animal allied to the monitor?) imbedded in a block of limestone.

This interesting specimen is in the possession of my friend R. Weekes, Esq. of Hurtperpoint. It is part of the right side of the lower jaw, about 1·6 inch long. It contains seven slender curved pointed teeth, the largest of which is 0·2 inch long. Mr. Konig, to whose notice it was submitted, thought it belonged to an animal allied to the monitor.

45. Portion of a rib slightly curved, and nearly flat.

Length 14 inches; width of the narrowest extremity 2·5 inches, of the widest, 3 inches; thickness, 0·8 inch.

This specimen bears a greater resemblance to the rib of a quadruped, than to those of the lacertæ

From this sketch of the strata and organic remains of the Tilgate strata, imperfect as it may be, several important inferences naturally arise: but as my information concerning these remarkable deposits is too limited and uncertain to warrant any general conclusions, I shall not at present presume to attempt an explanation of the phenomena they exhibit, but conclude with a brief recapitulation of the facts which this investigation appears to have established.

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* On the authority of Mr. Clift.

† Mr. Clift.

1. The country in the environs of Tilgate forest is composed of various beds of limestone and sandstone, covered with a layer of diluvial detritus; their total thickness being about thirty feet.

2. These deposits (so far as our knowledge extends) are of inconsiderable extent, occupying a district not exceeding fifteen square miles.

3. They contain the remains of oviparous quadrupeds and fishes; fresh water? and marine shells; and numerous vegetables.

4. Of these remains, a few only are sufficiently entire to point out the characters of the originals, the most considerable portion being reduced to fragments, and rounded by attrition; and all more or less broken and indiscriminately mixed together.

5. The more perfect examples are referable to the following animals and vegetables: *viz.*

An animal of the lizard tribe, of gigantic magnitude.

Other species of lacertæ, the characters of which have not been satisfactorily determined.

Three species of turtle, two of which are marine, and the third, a fresh water species; of the former, one is related to *Testudo mydas*, and the other to *T. imbricata*. The fresh water species resembles the fossil turtle of the Paris basin.

Two kinds of fishes related to recent species, at present inhabitants of our seas, (if not the same?) viz. *Squalus mustelus*, and *Anarhicas lupus*.

Several species of bivalve and univalve shell-fish; the former belonging to the genera mya and unio; the latter to the genera vivipara? or paludina? consisting of the same species as the shells of the Purbeck limestone.

The vegetables resemble in their general characters, certain plants peculiar to tropical regions, namely, the *Euphorbiæ* and *Dicksoniæ;* some of them are evidently the remains of *palms* and gigantic reeds; and one species is very similar to the common *Carex* of our rivers.

It results from these observations, that the animals and vegetables of the Tilgate strata, must have been overwhelmed by a fluid in a state of violent commotion, since they are generally broken, and their fragments promiscuously intermingled; yet from the perfect manner in which the teeth, scales, and other parts, are preserved in some examples, there is reason to conclude, that the originals were not transported from a distant country, but lived and died in the vicinity of the district, where their remains are now entombed.

In fact, the existence of dry land at no great distance, seems clearly indicated by these remains of vegetables and amphibia; some of the former must have grown on the borders of a river or lake; and the habits of the recent species, most nearly related to the latter, warrant a similar conclusion, since they are well known to frequent the rivers and marshy tracts of tropical regions, in the sands and banks of which they deposit their eggs.

Reflecting upon these extraordinary facts, may we not inquire with the illustrious Cuvier, "*At what period was it, and under what circumstances, that turtles and gigantic crocodiles lived in our climate, and were shaded by forests of palms, and arborescent ferns?*"

ON THE GEOLOGICAL POSITION OF THE STRATA IN THE ENVIRONS OF TILGATE FOREST.

The geological position of these beds is involved in much obscurity, and cannot at present be satisfactorily determined. The analogy which they bear to those of Purbeck[*] is however so striking, that the mind naturally

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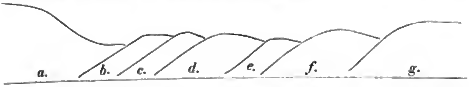
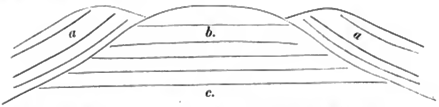
[*] The Purbeck beds occupy the highest place in the oolite series, and consist of thin strata of argillaceous limestone, alternating with schistose marls, forming an aggregate of more than 300 feet in thickness.

The fossils of the Purbeck stone consist chiefly of shells, which are supposed to resemble fresh water species, as the *viviparæ*, *cyclostomæ*, *planorbes*, &c.; impressions of fish, bones, assigns to both the same relative situation; yet the latter are well known to lie immediately beneath the iron sand formation, while the strata in question, are almost in contact with the weald clay, appearing on the surface, as represented in the annexed diagram.



a. Chalk of the South Downs. *b.* Blue chalk marl. *c.* Green sand. *d.* Weald clay. *e.* Sand. *f.* Tilgate beds. *g.* Iron sand.

It is obvious from this section, that the only hypothesis by which the connexion of the Tilgate and Purbeck beds can be rationally explained, is that of supposing them to form a protrusion through the iron sand; the relative position of the respective substances being such, that a denudation, or removal of the upper beds, could not have occasioned their present appearance. And as the thickness of the iron sand is estimated at 500 feet, the Tilgate strata, according to this supposition, must be situated on the summit of a hillock, or peak, 500 feet above the level of the uppermost beds of the Purbeck limestone.



a. a. Iron sand. *b.* Tilgate beds. *c.* Purbeck limestone.

and plates of one or more species of turtle; and the bones and teeth of an animal of the lizard tribe, allied to the crocodile. The circumstances under which these strata appear, differ greatly. They are distinctly seen in the Isle of Purbeck, and form a considerable district in Yorkshire, called the Vale of Pickering. *The same strata appear in Kent, rising together with others, from beneath the chalk; where from the coarseness of the limestone, it has been called the Kentish Rag.* (Phillips' Outlines of Geology.)

The discussion of this subject cannot, however, be pursued in this place, without leading to the anticipation of facts hereafter to be examined; it will therefore be more convenient to reserve any farther observations to the concluding section of this volume.

ON THE ANALOGY BETWEEN THE ORGANIC REMAINS OF THE TILGATE BEDS, AND THOSE OF STONESFIELD, NEAR OXFORD.

In the course of this inquiry, allusion has been made to the fossils of the Stonesfield slate, and their general resemblance to those of the Tilgate strata; this correspondence in the organic remains of deposits, whose geological relations are so entirely dissimilar, is a fact sufficiently interesting to require some attention.

The Stonesfield limestone is well known to belong to the middle beds of the oolite, and has long been celebrated for the extraordinary character of its fossils; of which, however, no detailed account has yet appeared before the public[*].

According to Dr. Kidd[†], it contains crabs, birds, tortoises, and one or more large quadrupeds; and the Rev. W. Conybeare, in his highly interesting memoir on the *Plesiosaurus*[‡], mentions, that it also incloses the remains of "an immense saurian animal, approaching to the characters of the monitor, and which, from the proportions of many of the specimens, cannot have been less than forty feet long."

With the assistance of Charles Lyell, jun. Esq. M. A. (of Bartley Lodge, Hants,) and aided by an interesting collection of Stonesfield fossils, for which I am indebted to his liberality, I have been able to ascertain that the following organic remains occur in both deposits, viz.

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[*] In the second part of the fifth vol. of the Geolog. Trans. just published, Mr. Conybeare states, that Professors Kidd and Buckland have been long engaged in the study of these interesting remains, and it is expected will shortly publish the result of their observations.

[†] *Geological Essays*, by J. Kidd, M. D. 8vo. 1815, p. 38.

[‡] *Geological Transactions*, Vol. 5. p. 592.

The teeth, ribs, and vertebræ of a gigantic animal of the lizard tribe.

Bones and plates of several species of tortoise.

Teeth of a species of squalus and anarhicas.

Scales of fishes, and lacertæ.

Bones of birds? and of quadrupeds?

A plant of the genus carex, allied to recent species. But the resemblance extends no farther; the *trigoniæ* and *belemnites* of the Stonesfield slate do not occur in the Tilgate beds; and the *viviparæ*, *euphorbiæ*, &c. of the latter, have not been discovered in the former deposit. It is scarcely necessary to add, that the limestone slate of Tilgate exhibits no traces of oolitic structure.

VII.

§ 1. 3. WEALD, OR OAK TREE CLAY; CONTAINING SUBORDINATE BEDS OF LIMESTONE AND SANDSTONE.

Syn.—Tetsworth Clay.—*Order of Superposition of the Strata, &c. by Professor Buckland.*

A tenacious clay, varying in colour from a yellowish brown to a dark bluish grey, and containing beds of limestone and sandstone, succeeds the iron sand deposit. It forms, as its name implies, a soil peculiarly favourable to the growth of the oak, the tract of country in which it predominates producing the finest timber in the county.

The weald clay appears on the surface, between the out-crops of the iron sand of the forest ridge, and the green sand, and its boundaries, are tolerably well defined by the basseting edges of those formations. Its occurrence is also indicated by the badness of the roads, and the luxuriant forests of oak with which it is covered in many places. It is of considerable extent and thickness. The wells sunk in it are deep, and the water generally of bad quality.

This deposit forms a vale from six to twelve miles in breadth, occupying the lowest part of the wealds of Kent and Sussex, and skirting the base of the chain of sand hills situate on the boundary line of the two counties. This vale commences near Pevensey, and runs parallel with the northern escarpment of the Downs, to Petworth and Haslemere, its inner margin extending to Horsham; it then passes into Surrey, and finally into Kent, where it obtains the same relative situation.

This clay is destitute of organic remains, but is well characterized by beds of argillaceous shelly limestone, that occur in various parts of its course in Surrey, Kent, and Sussex.

We shall now proceed to particularize a few localities of this deposit, and afterwards give a detailed account of the limestone strata, the geological history of which is particularly interesting, from their supposed analogy to the Purbeck.

At Swingate, near Plashett Park, in the parish of Ringmer, a well was sunk in the Weald Clay, to the depth of seventy feet; and at Mr. Hill's, on the Broyle, a well, ninety feet deep, was carried by borings forty feet lower; in both instances the water was brackish, and unfit for culinary purposes: no organic remains were discovered. The deepest borings in Mr. Hill's well brought up ironstone and sand.

On a farm belonging to Mr. John Rickman, at another part of the Broyle, trials were also made for water, but the result was equally unfavourable. To the intelligent proprietor of that estate, I am indebted for the following section:

Section of strata in the Broyle, near Ringmer, (communicated by Mr. John Rickman, of Wellingham.)

	Feet.
" 1. Ochraceous clay, becoming hard, and untractable when dry	5
" 2. Clay, with a thin vein of sand - - - - -	5
" 3. Blue oak-tree clay; tenacious when wet; crumbles very fine when exposed to the sun; a good manure for light sandy soils -	5
" 4. Yellowish brown clay - - - - - -	10
" 5. Clay of a light blue colour - - - - -	10
" 6. Clay of a deeper blue, impregnated with iron - - -	5

" At this depth a spring suddenly burst forth, and rapidly rose to the surface: it has continued to flow in a gentle stream, but the water is too strongly impregnated with iron to be fit for domestic use." In an adjoining field, Mr. R. bored to the depth of sixty feet, when the auger became immoveably fixed in a hard substance; probably a bed of Sussex marble*.

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* The well-diggers regard the occurrence of this limestone as a sure prognostic of good water, and assert that where it is absent, the water of the clay is brackish and unpalatable.

§ SUSSEX OR PETWORTH MARBLE.

Syn.—"*Marmor viridi-cinereum cochleis refertum.*" Da Costa's Nat. Hist. of Fossils, p. 235, No. lxxvii.

"*Marble from Petworth, Sussex.*" Woodward's Catalogue, vol. i. p. 20. x. *b.* 60[*].

This limestone is of various shades of bluish grey, mottled with green, and ochraceous yellow, and is composed of the remains of fresh water univalves, formed by a calcareous cement into a beautiful compact marble. It bears a high polish, and is elegantly marked by the sections of the shells which it contains. The shells belong to the genus vivipara of Montfort, (*Helix vivipara*, of Linnè,) and are supposed to resemble the recent species of our rivers: their constituent substance is a white crystallized carbonate of lime, and their cavities are commonly filled with the same substance, presenting a striking contrast to the dark ground of the marble. In other varieties the substance of the shells is black, and their sections appear on the surface in the form of numerous lines and spiral figures.

The Sussex marble occurs in layers, from a few inches to a foot in thickness, and these are commonly separated from each other by thin seams of clay, or of coarse friable limestone. It is frequently found in blocks or slabs, sufficiently large for sideboards, columns, or chimney-pieces, and but few of the ancient residences of the Sussex gentry are without them. There is historical proof of its having been known to the Romans, "and in the early Norman centuries it was much sought after, and applied as the Purbeck marble was, when cut into small insulated shafts of pillars, which were placed in the *triforia*, or upper arcades of cathedral churches, as at Canterbury and Chichester. At the first mentioned, the archiepiscopal chair is composed of it. Another more general use was for slabs of sepulchral monuments, into which portraits and inscriptions of brass were inserted. In the chancel at Trotton, there is a single stone, the superficial measure of which is nine feet six inches, by four feet six inches; and another, in the pavement of the cathedral of Chichester, measures more than seven feet by three and a half*." York Cathedral, Westminster Abbey, Temple Church, Salisbury Cathedral, and most of the principal gothic edifices in the kingdom, contain pillars or slabs of this marble. It is singular, that in Woodward's time, an opinion prevailed, that these pillars, &c. were artificial, and formed of a cement cast in moulds; but, as that author remarks, "Any one who shall confer the grain of the marble of those pillars, the spar, and the shells in it, with those of this marble got in Sussex, will soon discern how little ground there is for that opinion, and yet it has prevailed very generally. I met with several instances of it as I travelled through England, and had frequent opportunities of showing those who asserted these pillars to be factitious, stone of the very same sort with that they were composed of, in the neighbouring quarries †."

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[*] "Marble from Petworth, Sussex. The ground grey, with a cast of green. 'Tis very thick set in all parts, with shells chiefly turbinated. Some of them seem to be of that sort of river shell that Dr. Lister (*Hist. Cochlear. Aug.* p. 133.) called *Cochlea maxima, fusca sive nigricans, fasciata.* Several of the shells are filled with a white spar, which variegates and adds to the beauty of the stone. This is of about the hardness of the white Genoese marble." *An Attempt towards a Natural History of the Fossils of England*, by J. Woodward, M D. London, 1729, tome 1. p. 20.

Numerous examples of the durability of this limestone have been noticed above; yet from long exposure in damp situations, it undergoes decomposition, and the petrified testaceæ may then be extricated almost entire. The specimens, figs. 5, 6. tab. xvii. are examples of this kind; the slab delineated in the same plate is of the most compact and beautiful variety, that occurs in the south-eastern division of the county.

Mr. Young ‡ observes, that this limestone affords a very valuable manure, equal to chalk; and Hasted ‖ mentions, that a grey turbinated marble, greatly resembling it, is found at Bethersden, in Kent: specimens in my possession, from the last-mentioned locality, are perfectly analogous to the Sussex marble.

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* *Dalloway's Western Sussex*, chap. 26, page 145.
† *Woodward's Fossils*, loc. cit.
‡ *Young's Agricultural Survey of Sussex*.
‖ *Hasted's Kent*.

From the considerable depth in the Weald clay, at which this limestone generally occurs, its geographical extent cannot be accurately defined, our knowledge of its course depending, for the most part, upon such sections as are accidentally exposed, by the sinking of wells, or other artificial excavations. The information thus obtained is, however, sufficient to prove, that the beds traverse the county in a N.N.W. direction, extending from Kirdford, in Western Sussex, to Laughton, six miles N.E. from Lewes, from whence it proceeds eastwardly, and is lost in the alluvial marshes of Pevensey Levels. Wherever it approaches the surface, it occupies moderately rising ground, generally on the north side of a rivulet. The following list contains every locality with which I am at present acquainted:

Localities of the Sussex Marble.

Kirdford. In the quarries of the Earl of Egremont, lying on blue clay, twenty feet below the surface.

North Chapel. This locality is mentioned by Da Costa.

Petworth. The quarries are nearly four miles from the town, and the marble occurs in a bed of blue clay, at the depth of twenty-five feet. "The bed is horizontal, and is exposed to view in the ravines. It is divided by fissures into large slabs, fit for tables and other purposes, varying in thickness, from twelve to twenty-two inches, and is more or less compact*."

Wisborough Green.

West Grinsted †.

Friar's Oak Inn, on the Brighton road †.

St. John's Common: in blue clay, at the depth of a few feet beneath the surface, generally covered with a thin bed of loam. The limestone is of a deeper blue than in most other places, and the slabs, where in contact with the clay, are covered with a profusion of casts of univalves, lying in relief. The pathways leading to the cottages, situate on the road-side from hence to near Cuckfield, are generally paved with blocks of limestone, that have been dug up in sinking the neighbouring wells; by an attention to this circumstance, (which I have frequently noticed in other parts of the county) the marble may occasionally be discovered in situations, where its existence might not otherwise have been suspected.

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* I am indebted for this notice, to my excellent friend John Hawkins, Esq. F.R.S. &c. of Bignor Park, near Petworth.

† These localities were communicated by Richard Weekes, Esq. F.L.S. &c. of Hurstperpoint.

New Close; on Ditchling Common*.

Blackbrook Wood; beneath a bed of ochraceous clay, four feet thick.

Plumpton Green*; at the south end of the green, and to the north of the rivulet.

Street Green; it occurs under precisely similar circumstances.

Cooksbridge.

Plashett Park. A well sunk near a cottage in the south-eastern corner of the park, gave the following section:

	Feet.	Inches.	
1. Ochraceous loam	5	0	
2. Weald clay	5	0	
3. Sussex marble	0	5	
4. Weald clay	5	0	
5. Sussex marble	0	10	
6. Weald clay	9	0	
7. Sussex marble	0	10	
Spring of excellent water.			
	26	1	Total depth.

Short Gate. A well thirty feet deep in the Weald clay, passed through two beds of Sussex marble.

Broyle Place. In an adjoining field, blocks of the limestone are frequently exposed by the ploughs.

Laughton. In digging the foundation of the mansion lately erected by Colonel Downman, of the Royal Artillery, a fine bed of Sussex marble was discovered at the depth of ten feet. It is a very compact variety, and is separated by thin layers of marl into slabs, from six to twelve inches thick. A spring of excellent water issues from beneath the limestone beds, in a well thirty feet deep.

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* These localities were communicated by Richard Weekes, Esq. F.L S.&c. of Hurstperpoint.

In concluding this account of the Sussex marble, it may be proper to remark, that it appeared unnecessary to specify every variation in its texture or colour, since these differences are merely accidental, and do not affect the geological history of the substance under examination.

ORGANIC REMAINS.

The fossils of the Weald clay, consist only of the shells contained in the beds of limestone, and these do not present much variety. They are referable but to one genus, and consist of the following species:

1. Vivipara fluviorum? Tab. xvij. fig. 5, 6.

2. ——— extensa. Min. Conch. tab. xxxi. fig. 2.

From the apparent resemblance of these shells to the recent helices, (*Helix vivipara, et H. tentaculata,* of Linné) the limestone in which they are imbedded, has been supposed to be of fresh water origin. The correctness of such an opinion is, however, very questionable, since the characters of the fossils are not sufficiently defined, to admit of accurate comparison with their assumed prototypes [*].

The analogy between these strata, and the upper beds of the Purbeck, is so striking, that some eminent geologists have been induced to consider the Sussex marble as belonging to that series of deposits. But the testaceæ of the Purbeck limestone, although corresponding in many respects with the viviparæ of the Sussex marble, are of a more slender and elegant form, and certainly belong to a distinct genus. In short, after repeated examinations of the Weald clay with its imbedded limestone, in various parts of its course through Sussex, I have no hesitation in stating my conviction, that it is perfectly distinct from the Purbeck, and is separated from it by the iron sand formation, as represented in the annexed diagram:

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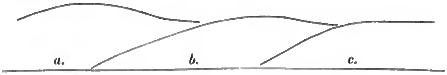
[*] Mr. G. Sowerby has favoured me with the following remarks on the specimens represented in tab. xvij. figs. 5, 6.

"I will briefly state the reasons which induce me to think the specimens in question are not of fresh water origin, and consequently not *paludinæ*. After a careful examination, I cannot perceive the least appearance of that kind of erosion, so characteristic of fresh water testaceæ, and which, though not constant, is in most cases observable in a greater or less degree. The substance of these shells is also considerably thicker than in any species of *paludina*; indeed for size, their thickness is very considerable.

"These fossils must not be confounded with the *viviparæ* or *paludinæ*, so common in the marl that lies over the fresh water beds at Headen-hill, in the Isle of Wight, and which are distinctly eroded, very thin, and of undoubted fresh water origin.

"The only recent shells that resemble the fossils you have submitted to my examination, are a small species of *turbo*, (of Linnè) approaching in its characters to *turbo littoreus*."



a. Weald clay, and Sussex marble. *b*. Iron sand. *c*. Purbeck limestone.

VIII.

§ 1. 4. Green or Chlorite Sand.

Syn. Phillips' Outlines of Mineralogy and Geology, p. 199.—*Smith's Strata*, p. 12.—*Professor Buckland's Order of Superposition of the British Islands.*

The term green sand, in its limited sense, is employed to designate certain strata of siliceous sand and sandstone, which compose the upper division of the "Green Sand Formation," and are interposed between the Weald clay and the lower beds of the chalk. A considerable portion of the sand "contains little round masses of a green substance, having a near resemblance to chlorite, and which sometimes are so abundant as to give a green tinge to the aggregate of which they form a part: from this circumstance, the deposit has also been distinguished by the name of "*Chlorite Sand.*" This substance, however, has not been chemically examined, and very probably may prove to be a suboxide of iron[*]."

In its course through Sussex, the green sand varies so much in its external appearance, physical characters, and mineral contents, that its outcrop is traced with difficulty. The strata comprised in this division, admit of the following synoptical arrangement, viz.

GREEN SAND.
- Thick beds and concretions of chert, (provincially termed whinstone,) with veins of chalcedony.
- White sand and sandstone.
- Red sand.
- Green sand.
- Passing into iron sand, and containing concretions of ironstone.
- Alternating with, and passing into soft grey sandstone.

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[*] *Phillips' Outlines.*

Such are the principal members of this deposit, that occur in Sussex. The lowermost beds first appear in the western part of the county at Haslemere, Blackdown hill, &c., where the layers and concretions of chert that characterize this division, are provincially termed *Whinstone*. These are succeeded by the ferruginous sand of Parham, which continues with but little interruption to Hurstperpoint, and there gradually passes into the red and white sand and sandstone of Ditchling. Proceeding in an easterly direction, the sand assumes its characteristic appearance, and at Westmeston, Cooksbridge, Wellingham, Ringmer, the Broyle, &c. perfectly resembles the chlorite sand of Wiltshire. Approaching Eastbourne, it passes into soft grey sand and sandstone, and is there terminated by the ocean.

The outcrop of the green sand thus briefly sketched, forms an inconsiderable tract of country, of variable breadth, extending from Eastbourne, to the western extremity of the county, and lying parallel with the northern escarpment of the Downs.

The subdivisions of this deposit in Sussex are not sufficiently important to require a separate description, and we shall therefore proceed to investigate the phenomena they present to our notice, without adhering to geognostic arrangement.

The beds and concretions of chert, occur principally in the western division of the county. This substance is a variety of hornstone; it occurs massive, is of a greyish yellow or greenish colour, has a conchoidal fracture, and a glimmering lustre. To my excellent friend, John Hawkins, Esq. F. R. S. &c. of Bignor Park, I am indebted for the following account of its characters and position.

"This stone is a compact mass of quartz, but not homogeneous, for it contains iron, and perhaps some other substance. It occurs in great abundance in the beds of our building stone, a ragged sandstone, which constitutes a chain of hills running E. and W. on the north side of the Arun and Rother: the strata there have a regular dip to the south, and basset out on the north. At Petworth and on the top of the high hill to the eastward, this hard stone is dug in great quantities for repairing the roads*, and I know not in any country a better material. It is usually disposed in irregular beds in the sandstone, but occasionally forms veins, which intersect the strata; I call the beds irregular, because they vary much in breadth and appear not to continue far.

"The WHINSTONE† shows a transition into the sandstone, and they are certainly of contemporaneous formation. In some situations near Petworth, great lenticular masses of this substance are imbedded in the friable sandstone, and these follow the same sedimentary line as the beds of sandstone, although separated from each other by very wide intervals: they are therefore unquestionably in situ. These masses frequently measure eight or ten feet by two or three, and are invariably surrounded by a more friable and ochraceous sandstone than the rest of the strata."

The Whinstone is sometimes traversed by veins of chalcedony, and it also contains cavities lined with mammillated concretions of the same substance ‡.

At Parham, near the village of Storrington, and in the adjoining parish of Rackham, the sand is highly ferruginous, and contains irregular concretions of ironstone. These beds, which are peculiarly interesting from the abundance and variety of their organic remains, were first noticed by my brother, through whose kindness I have obtained a fine series of specimens.

In Parham Park, the seat of Lord De-la-Zouche, the sand appears immediately beneath the turf, disposed in the following manner:

1. Surface soil, consisting of sand and vegetable earth; in some parts of a deep brown colour, approaching to black.

2. A thin layer of ferruginous sand, with small nodular masses of ironstone.

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* It was also noticed on Bexley Heath, and on the sides of Blackdown Hill, by Mr. Lyell.

† *Whinstone*, the name by which the chert is distinguished in Western Sussex, is probably of Saxon origin; it is unknown in the south-eastern part of the county.

‡ This circumstance was communicated to me by the Rev. C. P. N. Wilton, M. A. &c. of Blakeney, Gloucestershire.

3. Brown sand, with nodular concretions of sand, enveloping traces of zoophytes.

4. Yellowish brown friable sandstone, which hardens by exposure to the air; it contains numerous casts and impressions of bivalves and univalves.

5. Indurated sandstone of a deep brown colour, enclosing irregular nodules of ironstone.

6. Sand and sandstone to an indeterminate depth.

The fossils discovered in these strata, consist of the casts and impressions of many kinds of univalves and bivalves; and these occur in the greatest perfection in the more compact masses of the sandstone. Of the shells themselves not the slightest vestige remains, the cavities they formerly occupied being still empty: a circumstance that proves their destruction must have been effected by some chemical agent, subsequently to the consolidation of the sand, which now so beautifully retains their forms and markings.

By a careful comparison of the casts with the corresponding impressions, the following have been identified.

Organic Remains from Parham Park.

1. Fragment of an Echino-spatangus.

2. A small species of Patella, of an oval shape, conical, depressed; the casts of the interior of the shell only have been discovered.

3. Rostellaria *Parkinsoni*. Org. Rem. vol. 3. tab. V. fig. 11. It is evidently of the same species as the siliceous rostellarite of Devonshire, figured by Mr. Parkinson, and is readily distinguished by its alated outer lip with one spur-like process: the wreaths are from six to seven in number, and are slightly costated longitudinally.

4. Natica? A cast one inch long, the outer whorl being seven-tenths of the whole: volutions four or five. It very closely resembles the nerite, figured by Faujas St. Fond. Hist. Nat. de la Mont. de St. Pierre, Pl. xxviii. fig. 2.

5. Fragments of a species of Dentalium, 1·5 inch long, and 0·3 inch in diameter, at the largest extremity.

6. Mytilus. Casts of a small species, with acuminated beaks, the anterior side truncated and slightly curved; a few concentric markings, probably the lines of growth, are perceptible.

7. Modiola *imbricata?* Min. Conch. tab. 212. figs. 1, 3. The form of the casts so closely corresponds with that of the figures referred to, that I have but little hesitation in considering them as the remains of the same species, although the imbricated external surface has not been noticed in the Parham specimens.

8. Tellina. The casts of a small flat species; these are very numerous.

9. Cucullea. A few excellent casts in which the transverse teeth of the hinge (the characteristic mark of this genus) are very distinctly shewn; the impression of the external surface has not been observed. Some of the specimens are of the size and form of C. *decussata* (Min. Conch. tab. 206. figs. 3 and 4.), and in all probability belong to that species; an impression of the markings of the interval between the beaks, resembles those of C. *oblongata*, (Min. Conch. tab. 206. figs. 1 and 2.)

10. Trigonia *clavellata.* Min. Conch. tab. 87. The casts of this species are from three to four inches long, and exhibit the structure of the hinge and the situation of the muscular impression. The markings of the external surface, upon which its specific characters depend, are also beautifully preserved.

11. Trigonia *aliformis.* Min. Conch. tab. 215. The casts of this species are very bold and sharp, and seldom exceed an inch in width; the impressions of the external surface are not uncommon.

12. Venus. The casts of a shell of this genus are very numerous; it is an inch long, the width a little exceeding the length; the external impressions have not been observed.

13. Crassatella? The cast of a species allied to this genus.

14. Venericardia *planicosta?* Min. Conch. tab. 50. Several remarkably perfect casts of a venericardia, allied to this species, have been obtained from the more compact masses of the ironstone; they differ however from V. *planicosta* in their width exceeding their length, and in having but one muscular impression, which is placed near the posterior

margin. The appearance is too constant to be the result of accident, but it is difficult to explain the cause of this deviation from the usual structure of the shells of this genus. The specimens are from four to five inches and a half wide, and weigh from one, to one and a half pounds.

15. Mya *intermedia*. Min. Conch. tab. 76. fig. 1. The casts are very elegant, and correspond in every respect with the specimens of this species that occur in the sandstone of Bognor: the impression of the hinge tooth is very manifest.

It is a circumstance worthy of remark, that this shell should have been an inhabitant of the waters that deposited the green sand below the chalk, and of those which formed the sandstone of the London clay.

16. Pecten *quinquecostata*. Min. Conch. tab. 56. The lower or convex valve only has been observed; its form is precisely similar to the chalk specimens.

17. Perna. Impressions of the hinge of a species of this genus are preserved in some of the masses of ironstone in my cabinet; and a few casts of the shell were discovered in the sand by my brother. The largest specimen of the hinge is about three inches long, and exhibits six casts of the pits or depressions of the original; they resemble P. *aviculoides*, Min. Conch. tab. 66. in their general contour, but probably belong to a distinct species.

18. Terebratula *ovata*. Min. Conch. tab. 15. fig. 3. It is of an ovate form, rather depressed, smooth, and obscurely pentangular. This species also occurs in the green sand of Wilts.

19. Terebratula; a small striated species, in too imperfect a state to admit of determination.

Proceeding towards the eastern division of the county, the sand is observed holding its course in a line parallel with the northern escarpment of the Downs, at Henfield, Hurstperpoint, Stonepound, Keymer, &c.

In the pleasure grounds of W. J. Campion, Esq. of Danny, near

Hurstperpoint, it forms several banks of low elevation, but the sections which they present are inconsiderable and uninteresting.

On the south side of the turnpike gate at Stone-pound, the sand is of a reddish brown colour, mottled with yellow; on the north it lies beneath an alluvial deposit of,

1. Loam and ochraceous clay, about three or four feet.
2. Blue clay, containing a large proportion of sand, five feet.
3. Yellowish grey sand, from eight to ten feet.
4. Reddish brown sand;

these strata dip to the south.

The little town of Ditchling, situated near the foot of the Downs, stands upon a low mound or hillock of this deposit. Here the sand is of various shades of red and yellow, interspersed with white; and is inclined to the south, dipping beneath the blue chalk marl, which bassets out from under the chalk hills in the vicinity of the town.

South of Beechwood Green*, the sand rises to the surface, and forms a bank about eight feet high; in this spot it perfectly resembles the chlorite sand of Wiltshire. Near Cooksbridge, in sinking the well attached to the residence of Mr. Warren Lee, chlorite sand was also found at the depth of forty-five feet, beneath the blue chalk marl. Other localities of this bed occur in the vicinity of Lewes, of which the following are the most remarkable, and will serve to convey some idea of its course through this part of the county.

Localities of the Green Sand near Lewes.

At Wellingham, near the seat of Mr. John Rickman, covered with a layer of diluvial clay and pebbles.

Near the mansion of the late Wm. Green, Esq. beneath the blue chalk marl at the depth of thirty feet.

At the Park-house, in the parish of Ringmer, the well is sunk in chlorite sand, forty feet deep.

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* On the road side near Allchin's cottage.

At Norlington, in the same parish;—here the sand is of a red colour, and constitutes a low bank, near the house of Mr. New.

In a field east of Ringmer barracks, chlorite sand appears immediately beneath the turf, and also on the road-side near the fourth mile-stone.

At Willingdon, two miles N.W. of Eastbourne, the green sand is covered with a thick bed of diluvial sand, which occurs immediately beneath the surface, and varies from a light grey to a bituminous colour. This bed abounds with rounded fragments of fossil wood, that occur in great profusion in a bank on the road-side, near the residence of Mr. Putland. The specimens are incrusted with a covering of grey sand containing small pebbles of quartz, and internally are of a light reddish brown, clouded with darker shades of the same colour. The wood is calcareous, and bears a good polish, the transverse sections, displaying in a distinct and beautiful manner the radial insertions and annular markings, which denote the annual growth of the tree.

In some instances, the wood is studded with the remains of a small species of Fistulana *, of a pyriform shape, about 0·3 inch long, bearing some resemblance to F. *lagenula*, or F. *ampullaria*, of Lamarck; the bivalve part of the shell has not been detected, but is in all probability enveloped in the indurated sandstone with which the tubes are filled. This species of Fistulana appears to be new, and may be distinguished by the name of F. *pyriformis.*

The sand here described, extends to Arlington, Selmeston, &c.; and in a bank on the south side of the road, leading from Selmeston Fair Place, to Chilver Bridge, fossil wood of the same kind as that of Willingdon, has been noticed by Mr. Wm. Figg, jun.

At Chilley, near Pevensey, a bed of sandstone very strongly impregnated with bitumen, occurs beneath a thick layer of marsh land, or silt. It was discovered a few years since, by Mr. Cater Rand, of Lewes, while superintending the execution of some improvements in the drainage of

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* *Fistulana.* An equivalved bivalve, gaping, nearly toothless shell, included in a club-formed testaceous tube, open at the smaller extremity. *Org. Rem.* vol. iii. p. 199.

Pevensey Levels *. This substance is of a dark chocolate colour, is easily scraped with the knife, and emits a strong bituminous odour. Exposed to the action of the hydro-oxygen blow-pipe it burns with a bright flame, and fuses into a steel grey enamel †.

On the coast near Southbourne, the sand bassets out from beneath the chalk marl, and forms a low crumbling cliff, which extends but a short distance to the north, and then disappears beneath the alluvium of Pevensey Levels.

This sand is of a grey colour, and is thickly interspersed with particles of the green substance previously described; it also contains specks of mica. Where in contact with the superincumbent bed of chalk marl, it becomes intermixed with that deposit, and some of the fossils peculiar to each, are associated together at the line of junction. In a hasty visit to this spot, in the summer of 1818, I collected several species of Inoceramus, Pecten, Plicatula, Terebratula, Nautilites, Ammonites, Cirrus, a few Spongitæ, and other zoophytes. Few of these, however, are decidedly analagous to the species which occur in the green sand of Wiltshire: but partake more of the characters of the chalk marl fossils; indeed it is obvious, that the strata in this place are not exposed to a sufficient depth, to allow of our obtaining the usual productions of the former.

From what has been previously remarked, the general agreement between the fossils of the green, grey, and ferruginous sands of Sussex, and those of the chlorite sand of Wiltshire and Devonshire, is however sufficiently established. The *Trigoniæ*, *Cuculleæ*, *Rostellariæ*, *Pectinites*, *Terebratulæ*, &c. are common to each county, but the mode in which these remains are preserved differs remarkably. In Wiltshire, the shells have undergone but little change; in Devonshire, they are converted into chalcedony; in Sussex, with but few exceptions, they are entirely destroyed, their casts and impressions being the only indications of their former existence.

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* This bed was worked by the Romans, who employed it in the construction of part of Pevensey Castle. In the alluvial clay near Chilley, Mr. Rand discovered the remains of a Balista, and a considerable number of enormous balls of bituminous sandstone; the latter were in all probability intended to supply the engine, which (as is well known) was employed for hurling large stones.

† A specimen analysed by my brother, contained 15·4 per cent of bitumen.

ORGANIC REMAINS.

As these have been described in the preceding pages, it is only necessary to subjoin a brief catalogue.

1. Wood; in the sand of Willingdon, Selmeston, &c.
2. Patella *.
3. Rostellaria *Parkinsoni.*
4. Natica?
5. Dentalium.
6. Mytilus.
7. Modiola *imbricata.*
8. Tellina.
9. Cucullea *decussata.*
10. Trigonia *clavellata.*
11. ——— *aliformis.*
12. Venus.
13. Crassatella.
14. Venericardia *planicosta?*
15. Mya *intermedia.*
16. Pecten *quinquecostata.*
17. Perna.
18. Terebratula *ovata.*
19. ——— a small striated species.
20. Fistulana *pyriformis;* in the fossil wood of Willingdon, &c.
21. Echino-spatangus.

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* This and the following, with the exception of *Fistulana pyriformis*, are from Parham Park.

IX.

§ II. CHALK FORMATION.

Comprising 5. Blue chalk marl, or Galt.
6. Grey chalk marl.
7. Lower chalk.
8. Upper, or flinty chalk.

This formation constitutes one of the most striking features in the geology of Sussex. It forms four principal divisions, distinguished from each other by their chemical characters, and mineralogical productions.

The uppermost consists of chalk, with numerous parallel beds and layers of flint.

The next is the lower chalk, containing but very few flints, and in most localities being wholly destitute of them.

The third is the grey chalk marl, composed of chalk, and a considerable proportion of argillaceous earth.

The lowermost is the blue chalk marl, or galt, that intervenes between the grey marl and the green sand, and in some parts of its course, passes into a compact limestone.

The flinty chalk forms the summit, and the chalk without flints the central mass of the South Downs; the base of this range being composed of the grey marl, which is denuded in the deep vallies of the chalk, and in many places unites the insulated portions of that formation. The blue chalk marl rises from beneath the grey marl, and forms a narrow fillet of stiff land, on the northern edge of the Downs.

The relative situation of these deposits is shewn in the section annexed to the map; and in the plan of the stratification of the south-eastern part of Sussex, tab. III. fig. 1.

According to the plan adopted in this work, we shall commence our investigation with the lowermost deposit, the blue chalk marl.

X.

§ II. 5. BLUE CHALK MARL.

Syn.—Micaceous brick earth. *Smith's Strata*, p. 13.
Galt of Cambridgeshire. *Geological Transactions*, Vol. 5. p. 114.
Folkestone marl. *Phillips' Outlines.*
Malm rock. *Hawkins' Memoir. History of Sussex*, Vol. 2. p. 114.

This deposit consists of a stiff marl of a greyish blue, brown, or ferruginous colour. It contains nodular masses of indurated marl, and thin layers of a reddish brown schistose limestone. In western Sussex the beds afford good building stone.

The blue marl reposes upon the green sand, its basseting edge intervening between the outcrop of the latter, and the northern escarpment of the chalk hills. The denuded surface of this bed forms a soil remarkable for its tenacity, and which, in many parts of Sussex and Surrey, is distinguished by the provincial term, "black land:" it is thus described by Mr. Young: "At the northern extremity of the Downs, and usually extending the same length, is a slip of very rich and stiff arable land, but of very inconsiderable breadth; it runs for some distance into the vale before it meets the clay. The soil of this narrow slip is an excessively stiff calcareous loam, on a clay bottom; it adheres so much to the share, and is so very difficult to plough, that it is not an unusual sight to observe ten or a dozen stout oxen, and sometimes more, at work upon it. It is a soil that must rank amongst the finest in this, or any other country, being pure clay and calcareous earth*." It generally occupies low situations, and where uncultivated is covered by rushes and other plants, that affect a moist and clayey soil.

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* *Young's Agricultural Survey of Sussex.*

This deposit seldom exceeds 100 feet in thickness. It may be traced with but little difficulty, from near Laughton Place, six miles N. E. from Lewes, through Ringmer, Hamsey, Offham, Plumpton, near Ditchling, Clayton, New Timber, &c. to Beeding. West of the Adur, its place is occupied by a compact argillaceous limestone, provincially called Malm Rock; and which, from the observations of Mr. Hawkins, there can be no doubt is a contemporaneous formation. This malm rock continues along the foot of the Downs, near Sullington, Storrington, Amberley, Bignor, &c. to Petersfield in Hampshire.

On the south-eastern margin of the county, the blue marl disappears, and the grey marl reposes immediately upon the green sand; this circumstance is clearly shewn by the section of the cliffs near Eastbourne.

The identity of this bed with the blue marl of Folkestone*, the galt of Cambridgeshire, and the malm of Surrey†, cannot for a moment be doubted; not only is there a perfect agreement in their physical characters, but also in their geological position, and organic remains. The marl of Folkestone is said, by Mr. Phillips, to contain 30 per cent. of carbonate of lime; and that of Ringmer, upon being submitted to the action of acids, indicated a like proportion. In the absence of natural sections, an examination of the wells sunk in different parts of its course, are the only means we possess of obtaining a knowledge of the structure, and organic remains of this deposit. Availing myself of this source of information, I have succeeded in collecting a most interesting series of fossils, many of which are peculiar to this bed, and are engraved in the plates annexed to this volume.

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* The blue marl of Folkestone has been ably described by Mr. W. Phillips. Folkestone is built upon the green sand, and the cliffs on the east of the town are from 80 to 90 feet high, the upper part of which, for a considerable distance from their termination at Copt Point, consists of the blue marl. Crystallized sulphate of lime occurs in this bed, and numerous remains of shells with their pearly lustre still preserved. There can be no doubt that this deposit is altogether analogous to that, underlying the chalk at Malling in Kent, in Cambridgeshire and Oxfordshire, and which, in the latter counties, is provincially termed Galt. (*Geological Transactions*, Vol. 5, page 37.)

† At the foot of the chalk hills near Godstone and Bletchingley, the blue marl rises from beneath the grey marl; and I have collected from these localities precisely the same species of ammonites, belemnites, nuculæ, &c. as those which occur at Ringmer and Laughton.

It may be proper in this place to remark, that some eminent geologists appear to have confounded the *blue chalk marl* with the *Weald clay;* but the former invariably occurs *above* the green sand, and the latter *below* it. These beds are also remarkably distinguished from each other by their organic remains; the blue chalk marl abounding in belemnites and ammonites, while the clay (as previously remarked) is destitute of fossils, and its limestone contains shells of the genus *vivipara* only.

The following sections have been exposed by the sinking of wells in the vicinity of Lewes, and will serve to illustrate the characters and relations of this deposit.

WELLS SUNK IN THE BLUE CHALK MARL.

Laughton Place. Blue marl, 60 feet. The marl thrown out in deepening this well, contained Rostellaria *Parkinsoni*, aucula *pectinat*, N. *similis*, Ammonites *splendens*, A. *lautus* Belemnites *Listeri*, &c.; the last-mentioned fossil occurs in profusion in every locality of this bed; and at Laughton, is exposed on the surface of the ploughed lands.

Cottage in Moor Lane, parish of Ringmer. Blue marl, 50 feet. The lower beds were intermixed with a considerable proportion of green sand, and contained similar fossils to the preceding.

Ringmer Green. The wells vary from 30 to 90 feet in the marl, but good water never occurs until the bed is sunk through, and the green sand appears. In almost every part of this parish the marl encloses *hamites*, *ammonites*, *belemnites*, *innocerami*, *nuculæ*, &c.; three species of *crustacea*, an elegant species of *turbinolia*, and crystals of sulphate of lime.

Norlington Green, in the parish of Ringmer. Blue marl, 50 feet. The marl was not sunk through, and consequently no water appeared. There is no stratum in the south-eastern part of Sussex, that contains such an abundance and variety of organic remains, as the marl in this locality. From the depth of 15 to 50 feet the shells occur in prodigious quantities, the greater part having their nacreous covering preserved in the most beautiful manner. In addition to those previously mentioned, I have collected several species of crustacea, scales and vertebræ of fishes, teeth of the *squalus mustelus*, &c.; crystallized sulphate of lime, or selenites, was also very abundant.

In this well, at the depth of 20 feet, a layer of red marl, a few inches thick, was discovered, and another occurred 10 feet lower; this marl is sufficiently soft for marking on paper, and much resembles the red chalk used by artists, but is less pure and of a darker colour; meandering lines filled with a whitish earth, their outline bearing some resemblance to the linear leaves of graminiverous plants, were distributed through the mass. I have observed layers of red marl with precisely similar appearances, in the blue marl (or malm as it is there termed) of Bletchingley, in Surrey.

Cottage near the residence of the late Wm. Green, Esq. in the parish of Ringmer. This well gave the following section:

1. Yellow ochraceous loam, - - - - -	5 feet.
2. Blue marl, containing ammonites, inocerami, hamites, &c. and crystallized sulphate of lime, - - - - -	15 feet.
3. Dark blue marl, inclining to black, - - - - -	10 feet.
Small crystals of sulphate of lime were disseminated through the upper part of this bed; and in the lower, nodular masses of indurated marl, containing an intermixture of green sand, with small grains of quartz. These masses are permeated by veins of splendid pyrites, and their external surface is studded with groups of cubo-octaëdral crystals of the same substance.	
4. Green chlorite sand, - - - - - - -	4 feet.
Total thickness,	34 feet.

At this depth a spring of excellent water suddenly appeared, and rose to the height of 10 feet.

Cottage of Mr. Warren Lee, near Cooksbridge.

Blue marl, containing hamites, ammonites, nuculæ, &c. -	95 feet.
Marl, with a great proportion of chlorite sand without organic remains, - - - - - - - - - -	45 feet.
	140 feet.

Chiltington, on the estate of John Marten Cripps, Esq. M. A.

Blue marl, containing nuculæ, inocerami, ammonites, &c.	90 feet.

Near New Timber (communicated by Richard Weeks, jun. Esq. F. L. S. of Hurstperpoint).

1. Grey chalk marl, gradually passing into the next bed, -	20 feet.
2. Blue chalk marl, enclosing immense numbers of ammonites, inocerami, nuculæ, &c. - - - - - - - -	70 feet.
	90 feet.

It is unnecessary to multiply examples; the sections above described exhibit every material variation observable in the characters of this deposit, in the south-eastern part of Sussex; we shall now pass to the investigation of the limestone beds that occur in the western division.

MALM ROCK OF WESTERN SUSSEX.

The *Malm Rock* has been already mentioned, as occupying the same geological position as the blue marl. It is a compact argillaceous limestone, of a blueish grey colour, the lower beds being hard and durable, and affording a good material for building*. "The grey chalk passes insensibly into the malm rock, which forms a basement to the chalk hills of more than half a mile in breadth, and constitutes the substratum of a good corn soil. It may be traced with but little interruption from Sullington, near Storrington, to Petersfield."

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* My friend J. Hawkins, Esq. favoured me with a series of specimens, shewing the gradual transition of the grey marl into the malm rock.

"A belt of blue clay appears on the north, the geological relation of which to the preceding has not been ascertained. It invariably accompanies the malm rock in the direction here pointed out, and is succeeded by a narrow and parallel deposit of ferruginous sand*, slightly indurated, the surface of which, if we may draw any inference from some insulated beds of gravel that occur on the highest points, must once have presented an uniform extent of table land†."

Organic Remains.

The fossils of the blue chalk marl, like those of other argillaceous strata, are remarkable for their beauty, the pearly covering of the shells being in most instances preserved.

1. Vegetables. Wood is stated by Mr. Phillips to occur at Folkestone; but I have not observed any decided remains of vegetables in the blue marl of this part of Sussex.

In the malm rock near Amberley, the Rev. J. Hanley has recently discovered the remains of a large tree, in which the ligneous structure of the original is very distinctly exhibited‡.

2. Turbinolia *Konigi*, tab. xix. fig. 22 and 24.

Inversely conical, aperture circular, divided by numerous perpendicular lamellæ, radiating from the axis to the circumference; axis simple; margin crenulated; external surface longitudinally striated; striæ from 25 to 30, distinct, prominent; base convex.

This elegant little coral is from 0·4 to 0·5 inch in diameter, and about 0·3 inch high; the lamellæ are numerous, generally exceeding 50; the striæ on the external surface are distinct, proceeding from the base to the margin, where they unite with the lamellæ alternately.

This fossil occurs in every locality of the blue marl near Lewes, and appears to be one of its most characteristic productions. It has also been found at Godstone in Surrey, Malling in Kent, and in Cambridgeshire. I have named it in honour of Charles Konig, Esq. of the British Museum, whose attainments in mineralogical science, can only be equalled by his zealous exertions for the prosperity of the national institution to which he is attached.

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* This bed belongs to the green sand, and has been already described in the account of the strata at Parham Park.

† Extract of a letter from J. Hawkins, Esq. Bignor Park.

‡ On the authority of J. Hawkins, Esq. F. R. S.

Fig. 22, the upper surface; fig. 24, the base.

3. Turbinolia. A small species, inversely conical, compressed, aperture oval; the lamellæ numerous, distinct; axis void; the external surface covered with minute longitudinal striæ, which unite with the lamellæ at the margin.

A few imperfect specimens only have been discovered.

4. Echino spatangus; this specimen resembles the echinite from Devizes, figured by Mr. Smith, as peculiar to the brick earth. (*Smith's strata, Brick earth*, fig. 3.)

5. Fragments of a ventricose univalve, its genuine characters not distinguishable.

6. Cirrus *plicatus*. (*Min. Conch.* Vol. 2, tab. 141. fig. 3.)

A conical univalve, transversely striated; having the umbilicus plicated. Occurs occasionally at Ringmer.

7. Rostellaria *carinata*. Tab. xix. fig. 10, 11, 12. 14.

Turreted, spirally striated; whorls, eight or nine; ornamented with a row of tubercles; body of the lower volution strongly carinated above the middle, and terminating in a spinous process on the outer lip.

The casts of this shell are composed of indurated marl of a glossy black colour, and but rarely occur in a perfect state. In some specimens portions of the shell are still visible, and these shew that the original was covered with minute transverse striæ; the tubercles on the shell are more elongated than in the casts, assuming the form of ribs.

This species occurs at Laughton, Ringmer, Norlington, &c.

Tab. xix. fig. 10, casts of the spire attached to a block of marl.

Fig. 11. A fragment of the summit of the spire covered with the shell; this elegant specimen exhibits the spiral striæ, and the elongated tubercular projections.

Fig. 12. A cast in argillaceous ironstone; the front of the lower whorl is seen in this specimen, but the outer lip is wanting.

Fig. 14. exposes the lower wreath with its carinated ridge, and spinous process.

8. Ampullaria *canaliculata.* Tab. xix. fig. 13.

Ventricose, whorls, three or four; transversely and obliquely striated; the striæ decussating each other; spire short, turns of the spire separated by a deep channel.

9. Natica? Tab. xix. fig. 31, 32.

These shells are from Norlington, but are too imperfect to admit of accurate determination.

10. Dentalium *striatum.* Tab. xix. fig. 4. (*Min. Conch.* tab. lxx. 4.) Slightly arched, longitudinally striated; striæ ten or eleven, aperture circular.

Is of frequent occurrence at Folkestone, but is very rare in Sussex.

11. Dentalium. Tab. xix. fig. 28.

This specimen is longitudinally striated, and much compressed; it is in too mutilated a state to allow of specific distinction.

12. Dentalium *ellipticum.* Tab. xix. fig. 21, 25. (*Min. Conch.* tab. lxx. 6, 7.)

Nearly straight, slightly compressed, aperture circular, external edge elliptical.

The substance of the shell being thinner laterally, than on the anterior and posterior margins, the external outline of the tube is of an elliptical form, although the aperture is perfectly circular. The annular markings occasioned by the lines of increase are very numerous, and render the surface uneven. The shell is changed into a white pulverulent carbonate of lime; casts of the interior, having a black polished surface, are not uncommon. Mr. Sowerby remarks, "that they are beautiful oblong cones, which remain after the shell is decomposed, and have often puzzled collectors, from the difficulty of ascertaining their origin."

Tab. xix. fig. 21. A specimen in which the shell is preserved.

Fig. 25. A cast of indurated marl.

13. Nautilus *inequalis*. Tab. xxi. fig. 14, 15. (*Min. Conch.* tab. xl. 2, 3.) Involute, spheroidal, umbilicate, aperture obovate; septa entire, slightly concave, the inner septa deeper than the outer; siphuncle placed near the inner margin.

The specific name of this elegant shell is taken from the remarkable structure of its septa, which diminish in depth as they approach the aperture; while, in every other species, they increase in size with the age of the animal.

Tab. xxi. fig. 14. Front view of a cast from Norlington.

——— fig. 15. Lateral view of the same specimen. This cast is composed of indurated marl, impregnated with iron; remains of the shell changed into carbonate of lime, form the curved lines which mark the division of the chambers.

14. Belemnites *Listeri*. Tab. xix. fig. 17, 18, 23.

——— *minimus; Lister. Hist. Anim. Angliæ*, p. 228, fig. 32.

Subfusiform, cylindrical, with one slight longitudinal sulcus; apex pointed; siphunculus central, extending through the alveolus to the apex of the spathose part.

The form of this beautiful little belemnite varies considerably; some of the specimens are fusiform, others gently taper towards the apex; some are perfectly cylindrical, and others contract suddenly. Their constituent substance is a spathose crystallized carbonate of lime, of a radiated structure, varying from a dark brown to a light amber colour; many of the specimens are nearly opaque, but the greater part are pellucid. The largest example in my collection is 0·2 inch in diameter, and 1·3 inch in length. Upon the application of a slight force in the direction of the sulcus, they separate longitudinally, and expose sections of the chambered structure of the shell, with the siphunculus extending through the spathose substance to the apex. These fossils occur in profusion in every locality of the blue marl in Sussex; and also in Surrey, Kent, and Cambridgeshire. The same species is found at Stutgard *.

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* *Geological Transactions*, vol. v. p. 58.

The specimens delineated are from Ringmer.

AMMONITES.

The ammonites of this deposit, are equal in elegance and beauty to any hitherto known. When first collected, they retain in general a considerable portion of the original shell, with its nacreous covering heightened by the changes it has undergone in the mineral kingdom. They are very iridescent, and in many instances derive a golden lustre from an impregnation with sulphuret of iron, that renders their appearance remarkably splendid [*]. Their cavities are filled with pyrites, indurated marl, and argillaceous ironstone, and from the excellent state in which the septa are preserved, their foliaceous structure is shown in numerous examples.

In the *Dictionnaire d'Histoire Naturelle*, mention is made of a bed of clay, in the vicinity of Moscow, where ammonites occur under similar circumstances, and apparently in the same state of preservation [†].

15. Ammonites *splendens*. Tab. xxi. figs. 13, 17.

Involute, depressed, carene flat, with carinated margins; volutions three or four, deeply inserted, flat, transversely radiated; radii depressed, curved towards the aperture; a row of distant elongated tubercles on the inner margin; aperture sagittate; dissepiments foliaceous; siphunculus internal.

The external volutions rapidly increase in breadth, the inner ones being three-fourths concealed. Two or three radii arise from each tubercle, and proceed with an elegant curve from the inner to the outer margin, where they terminate in angular projections, and form the crenulated margin of the keel. The septa are sinuate, and very foliaceous. The siphunculus is placed near the inner margin. The aperture is nearly equal in length to half the diameter of the shell, and is deeply indented by the inner whorls. The remains of this truly splendid ammonite are common at Ringmer and Laughton, the specimens varying from half an inch to two inches in diameter. Small specimens are sometimes found with the carene rounded, and the wreaths nearly destitute of radii, in which state they might easily be mistaken for a distinct species.

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[*] The pyrites upon which the beauty of these fossils principally depends, undergoes decomposition upon exposure to the air, even for a short period; a circumstance that occasions the destruction of nine-tenths of the specimens, after they have lain in the cabinet of the collector but a few weeks. I have employed various means for their preservation, but without success; varnishes, gum water, albumen, &c. destroy their lustre, and give them an unpleasant appearance.

[†] "J'en ai vu d'immenses quantités des ammonites dans les couches d'argile qui forment le rivage de la Moscoua, près de Moscou, à cinq ou six pieds seulement au-dessous de la surface du sol. Elles sont toutes d'une grandeur médiocre et n'excèdent pas cinq à six pouces de diamètre; elles sont de l'espèce qui est articulée et décorée d'arborisations. Rien n'est si beau que ces cornes d'ammon dans l'instant où on les retire de leur gite; elles sont rêvetues d'une couche pyriteuse couleur d'or et gorge de pigeon; mais dès qu'elles ont pris l'air, elles s'effleurissent et tombent en miettes. Elles sont mêlées des beaucoup de bélemnites, qui sont également d'une volume médiocre. *Dict. d'Hist. Nat.* p. 332. tome vi.

Tab. xxi. fig. 13. A portion of the outer volution covered with the shell.

——— Fig. 17. A cast in pyritous marl, exhibiting the sinuous septa; small crystals of sulphate of lime are contained in cavities on the opposite side of this specimen, and pseudomorphous iron pyrites is disseminated throughout the mass.

16. Ammonites *auritus.* Min. Conch. tab. 134, vol. ii.

"Compressed, with obscure radiating undulations, tuberculated at their origin; inner whorls exposed; back deeply channelled, bordered by large, alternating, compressed tubercles."

Fragments of this species occur at Ringmer; but none have been discovered sufficiently perfect for representation.

17. Ammonites *planus.* Tab. xxi. fig. 3.

Involute, depressed, volutions deeply inserted, obscurely marked with curved striæ; carene flat, with crenulated borders; aperture sagittate; dissepiments sinuate.

The surface of the volutions is nearly smooth, the striæ being indistinct, and in some specimens imperceptible (as in the figure). The inner wreaths are three-fourths concealed; the situation of the siphunculus is unknown.

This species is nearly allied to A. *splendens,* but differs from it, in being destitute of tubercles on the inner margin of the volutions, and in the absence of the radiated markings, with which the surface of the former species is adorned.

The specimen represented (tab. xxi. fig. 3) is from Ringmer; the shell is nearly entire, and most beautifully iridescent.

18. Ammonites *lautus*. Tab. xxi. fig. 11. (*Geolog. Trans.* vol. v. p. 58.) Involute, depressed, volutions inserted, transversely radiated, radii strongly curved, arising in pairs from a row of oblique ridges on the inner margin, and terminating with intermediate rays on the outer edge: carene deeply channelled, bordered by alternating compressed tubercles; dissepiments very foliaceous.

The volutions are three or four in number, and two-thirds concealed. The rays arise in pairs from the ridges of the inner edge, and being joined by one or two intermediate ones, proceed with an elegant sweep to the outer margin, where they terminate in obtuse flattened tubercles, generally three or four to each tubercle. The carene is deeply channelled, the edges serrato-tuberculate, the tubercles being disposed alternately. The aperture is obscurely sagittate, and equal in length to half the diameter of the shell. The situation of the siphunuclus is unknown.

This species resembles A. *auritus* (of Sowerby), but is distinguished by its prominent curved rays, by the ridges on the inner volution being less tubercular, and the inner volutions two-thirds concealed. It occurs at Laughton, Ringmer, and Norlington.

The figure is from a specimen in which the shell is entire.

19. Ammonites *biplicatus*. Tab. xxii. fig. 6.

Depressed, slightly umbilicate; volutions inserted, transversely radiated; rays prominent, curved, bifurcated, arising from a row of oblong projections on the inner edge of the volutions, and terminating in tubercles on the outer margin; carene flat, bordered by alternating, compressed tubercles.

The volutions are three or four, the tubercles on the inner margin distinct, each giving origin to a pair of rays that terminate in a tubercular projection on the edge of the keel. The inner volutions are two-thirds concealed, the inner row of tubercles alone being visible. The carene is nearly flat between the tuberculated margins by which it is bordered.

The aperture is obtusely sagittate, and its length rather less than half the diameter of the shell.

This species is thicker than A. *lautus*, and differs from it in the flatness of the keel, and in having but two rays to each tubercle; it may be distinguished from A. *auritus*, by the insertion of the wreaths.

Tab. xxii. fig. 6. A cast of indurated marl, partially covered with the remains of the shell.

20. Ammonites *tuberculatus*.

Involute, umbilicate, umbilicus expanded; volutions rounded, inner whorls nearly two-thirds exposed; inner margin oblique, smooth, a row of strong tubercles in the centre of each volution, united by oblique transverse ridges to a corresponding row on the outer margin; carene broad, bordered by opposite diverging tubercles; aperture obovate.

A strongly marked shell, composed of three or four volutions, ornamented with remarkably prominent oblong tubercles, which, in some instances, are 0·4 inch high; these are placed obliquely, and united by ridges that arise in pairs from the inner row. The inner volutions are partly inserted, the outer row of tubercles being concealed. The middle of the carene has a deep narrow sulcus or groove, and is bordered by the marginal set of tubercles. The umbilicus is in the form of a broad inverted cone.

This species differs from the last, in the situation and size of its tubercles, and in their being united by single ridges, which are not curved; in the volutions being more exposed, the carene sulcated, and the marginal tubercles opposed to each other, instead of alternating; this circumstance also separates it from A. *auritus*. The septa are very foliaceous. It occurs at Ringmer[*].

HAMITES.

Fragments of the straight part of the shells of this genus, are very common in every locality of the blue marl; some of them possess a pearly lustre, equal in beauty to the ammonites, and others show the foliaceous sutures of the dissepiments; in this state they are the *Baculites* of some authors. The hooked part of the shell is very rare, but I have had the good fortune to discover a few specimens, that exhibit the form of the original in a more perfect manner, than in any examples previously noticed.

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[*] Mr. Parkinson describes three other species of ammonites from the blue marl of Folkestone, viz. A. *serratus*, A. *pansus*, and A. *ornatus*. Fragments occur in this neighbourhood which, in all probability, belong to some of these; but they are too imperfect to allow of their characters being distinguished with certainty.

21. Hamites *attenuatus*. Tab. xix. figs. 29, 30.

Cylindrical, suddenly attenuated immediately beyond the curve; annular undulations numerous, obtuse.

"The larger limb is suddenly contracted near the curvature; and the lesser one is consequently very slender in proportion." The undulations are obscure at the back *. Mr. Sowerby, in the specific description, states that it is slightly compressed; but this circumstance is evidently the result of accident, the true form of the original being perfectly cylindrical. This species occurs at Laughton, Ringmer, and Norlington, and has also been discovered in Kent and Surrey.

Figs. 29 and 30 are delineations of two remarkably interesting specimens, the smaller limbs in both instances being nearly perfect, and exhibiting an excellent type of the structure of the shells of this curious genus. They were found at the depth of thirty feet, in the well attached to the cottage of Mr. Warren Lee, near Cooksbridge, and are partly imbedded in the blue marl. The lesser limbs are flattened by compression, and the interstices between the annular costæ are partially filled with the surrounding matrix. The shelly covering is beautifully iridescent.

22. Hamites *maximus*. *Min. Conch.* tab. lxii. fig. 1.

"Slightly depressed? undulations even, rounded, disappearing at the back, curvature gradual †."

Fragments of this species have been found at Ringmer, Norlington, &c.

23. Hamites *intermedius*. Tab. xxiii. fig. 12. (*Min. Conch.* tab. lxii. 2, 3.)

Slightly depressed, costated, costæ annular, oblique, obtuse; curvature rounding.

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* *Min. Conch.* vol. i. p. 137.

† *Ibid.* vol. i. p. 138.

Numerous fragments of this species occur at Ringmer, Norlington, and Laughton.

The specimen delineated, tab. xxiii. fig. 12, is probably a variety, since the costæ are larger and less numerous than usual; the foliaceous septa are seen in the upper part of this specimen.

24. Nucula *pectinata.* Tab. xix. figs. 5, 6. 9. (*Min. Conch.* tab. 192, 6, 7.)

Transversely elliptical, elongated, convex, longitudinally striated; striæ diverging from the beaks to the margin, decussated by fine transverse lines; posterior side truncated; lunette depressed, cordiform; margin serrated.

The surface of this elegant shell is marked with longitudinal striæ, crossed by transverse lines, and separated by fine sulci; the latter are but obscurely shewn in perfect specimens, but are very conspicuous in those that are worn. In the adult shell the lines of growth are numerous and distinct. The constituent substance of these fossils is a light fawn-coloured carbonate of lime; their cavities being filled with argillaceous ironstone, which forms bold casts when the shell is decomposed. The lunette at the truncated extremity is large, and characteristic of the species. The situation of the teeth of the hinge, and the muscular impressions, are shewn in the casts.

This shell occurs in almost every locality of the blue marl, to which it is considered to be peculiar.

Tab. xix. fig. 5. A cast exhibiting the impression of the hinge, the serrated margin, and the eminences formed by the deep muscular impressions.

Figs. 6 and 9, are different views of a perfect shell.

25. Nucula *ovata.* Tab. xix. figs. 26 and 27.

Transversely ovate, rather depressed, obscurely striated transversely; lunette slightly impressed, cordate, elongated; margin entire.

This species of nucula is of a transverse oval form, and its surface is nearly smooth; the striæ being very minute. The lunette is cordiform, very shallow, and elongated.

Tab. xix. fig. 26. A specimen covered with the shell, the anterior side broken off.

——— fig. 27. A cast of indurated marl, from Laughton Place.

26. Inoceramus *concentricus*. Tab. xix. fig. 19. (*Geolog. Trans.* vol. v. tab. 1. fig. 4.)

Subcordiform, longitudinally, concentrically sulcated; beaks converging, recurved; lower valve gibbous, produced; margin entire.

This shell was first described by Mr. Parkinson, in the Geological Transactions: it had however been long known as a production of the blue marl, but the imperfect state in which the specimens usually occurred, prevented its characters from being previously ascertained. It is a small species, of the curious genus formed by Mr. Sowerby, for the reception of the large fibrous bivalve of the chalk. The specimens seldom exceed 1·2 inch in length. The shell is nearly cordiform, and marked by gentle concentric grooves, the eminences between them being rounded. The lower valve is gibbous, and produced at the beak nearly one-fifth of its longest diameter; the upper valve is smaller and more expanded. The beaks are approximate, and slightly recurved.

It occurs in every known locality of the blue marl.

Tab. xix. fig. 19, is a remarkably perfect specimen, still retaining a considerable portion of the shell.

——— fig. 15, represents the produced part of the beaks detached from the body of the shell; examples of this kind are not unfrequent.

27. Inoceramus *sulcatus*. Tab. xix. fig. 16. (*Geolog. Trans.* vol. v. pl. 1. fig. 5.)

Subcordiform longitudinally; with deep, radiating, oblique, longitudinal sulci; beaks recurved, lower valve produced, margin undulated.

In the position of the beaks, and general form of the valves, this species corresponds with the former; from which, however, it is remarkably distinguished by its longitudinal furrows. These commence at the beak, and radiate with an oblique curve towards the margin, enlarging as they proceed. The ridges that separate the sulci are rounded, and are from seven to nine on each valve. Mr. Parkinson observes, "that on the surface of the casts, are seen small and close transverse rugæ." The specimens seldom exceed 1·5 inch in length, and are found in every locality of the blue marl.

The figure is from an argillaceous cast, in which the pearly covering of the shell is preserved.

28. Inoceramus ———. Tab. xix. fig. 20.

Other species of this genus, occur at Ringmer and Norlington, but in too mutilated a state to admit of description. The beautiful specimen delineated, fig. 20, tab. xix. is remarkable for possessing the fibrous structure observable in the Inocerami of the chalk; and for retaining its crenulated hinge; this shell is probably a variety of I. *concentricus*.

29 and 30. Tab. xix. figs. 7 and 8, represent two argillaceous casts of bivalves from Norlington, the genera of which cannot be correctly ascertained. The former is a front view of a cordiform bivalve, perhaps related to the Isocardiæ; the latter probably belongs to the genus Arca: they are both solitary examples.

Crustacea.

The remains of this order of animals, are so exceedingly rare in the blue marl, that with the exception of a few fragments, the delineations in tab. xxix. comprise every specimen that has occurred in Sussex.

To the kindness and liberality of William Elford Leach, M. D. of the British Museum, who did me the favour to compare them with the recent species, to which they are most nearly related, I am indebted for the following identification of their genera.

31. Tab. xxix. figs. 7, 8. 14. "A species of a new genus of the family *Leucosiadæ* *, nearly related to the genus *Arcania*." Dr. Leach.

In these specimens the shell or crust of the thorax alone remains. It is of a suborbicular form, rather inflated, obscurely trilobate, with twelve or thirteen aculeated tubercles; the margin is dentated.

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* The recent *Leucosiadæ* have two or four small quadriarticulate antennæ inserted between the eyes. The tail is naked; they have eight legs, all furnished with claws; and two chelate hand claws. *Rees' Cycloped. Art. Cancer.*

From Norlington Green.

Fig. 8, the upper, and fig. 7, the under surface of the same specimen. Fig. 14 is a younger example of this species.

32. Tab. XXIX. figs. 9, 10. " A species of a genus of the family *Corystidæ**, allied to a new Indian genus in the cabinet of Dr. Leach."

The shell is oblong, ovate, depressed; the surface covered with minute granulæ, the margin bidentated near the front. No vestige of the legs, antennæ, or claws, remain.

From Ringmer.

Fig. 9, the under, and fig. 10, the upper surface of the same individual.

33. Tab. XXIX. figs. 11, 12. " A species of the genus *Etyus*, of the family *Canceridæ*." Dr. Leach.

Transversely obovate, obscurely trilobate; the surface covered with irregular papillæ.

From Ringmer.

Fig. 11, the under, and fig. 12, the upper surface of the same example.

34. Tab. XXIX. figs. 13, 15, 16.

" These belong to a genus of the family *Corystidæ*, intimately related to *Corystes*." Dr. Leach.

This species is longitudinally obovate, convex, with a tuberculated dorsal ridge, having a row of three tubercles on each side. The shell is truncated posteriorly, and the margin laterally tridentated. The abdomen is composed of six or seven arcuate segments, and there are three or four legs on each side.

Fig. 13. An imperfect specimen of the thorax.

Figs. 15, 16. Different views of the same fossil. In the former, the abdomen is seen folded beneath the thorax, and there are rudiments of legs, on each side. The latter shews the upper surface with the tuberculated dorsal ridge; the commencement of the abdomen appears at the base.

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* The *Corystidæ* have four antennæ; the external pair approximate, setaceous, ciliated, and very long. The eyes remote and pedunculated. The shell is oval, and longer than wide; the tail folded under the body when the animal is in a state of repose. They have ten legs; the anterior pair chelate, the others terminating in an acute elongated nail or claw. Vide *Lamarck*, *Animaux sans Vertèbres*, tome V. 233.

35. " Fragments of the abdomen of two kinds of *Astacidæ*." Dr. Leach.

These are too imperfect to require any observation.

REMAINS OF FISHES.

These occur so rarely, that the following are the only examples in my possession.

36. Scales of some unknown fish.

37. A small vertebra.

38. A tricuspid tooth; resembling those of Squalus *mustelus*.

ORGANIC REMAINS OF THE MALM ROCK OF WESTERN SUSSEX.

I am unable to give any satisfactory account of the fossils of this bed; and none are enumerated in Mr. Hawkins' catalogue of the organic remains of that division of the county.

My friend, Mr. Chassereau of Brighton, discovered the culm or stem of some arundinaceous plant in the limestone, near the Roman villa, at Bignor; and also the impression of a coriaceous nut, perhaps of a species of *areca*.

In the same locality, white linear markings, resembling those of the red marl at Norlington, are very numerous between the laminæ of the malm rock; are these the remains of algæ? of fuci? or of corallines?

Near Amberley Castle, Mr. Chassereau observed ammonites and inocerami; and Mr. Hawkins has lately informed me, that some fine crabs have been found in the grey limestone of that parish. The fossil tree, discovered by Mr. Hanley, has already been noticed.

XI.

§ II. 6. GREY CHALK MARL.

This deposit constitutes the foundation of the chalk hills, its outcrop forming a fillet, or zone, round their base, and connecting the detached parts of the range with each other.

The texture of the marl is commonly soft and friable, but indurated blocks occur, which possess the hardness of limestone. It is of a light grey colour, inclining to brown, and frequently possesses a ferruginous tinge derived from oxide of iron. It principally consists of carbonate of lime and alumine, with an intermixture of silica, a very small proportion of iron, and perhaps of oxide of manganese.

Where denuded, the surface of this deposit composes a fertile tract of arable land, including some of the best farms in the county.

In the range of low cliffs near Eastbourne, the grey marl is seen rising from beneath the chalk, and reposing on the grey sand, with which it is intermingled at the line of junction. Its separation from the superincumbent bed of chalk without flints, is well defined, and may be traced with but little difficulty. From this spot it extends with scarcely any interruption, to Shoreham river, its outcrop being interposed between the foot of the Downs, and the basseting edge of the blue marl.

In western Sussex it occupies the same relative position, the lower chalk passing insensibly into the grey marl, and the latter into the malm rock.

In its course through this tract of country, it forms a few hillocks or mounds of low elevation, which are remarkable only for the abundance and variety of their fossil remains. I shall proceed to notice a few of the more interesting localities.

A low bank at Middleham, in the parish of Ringmer, near the seat of the Rev. J. Constable, contains *hamites, turrilites, nautilites, ammonites,* and *inocerami.* The largest turrilite hitherto discovered was collected near this spot, and is figured in *Min. Conchology,* tab. lxxiv.

Stoneham, near Lewes; from a marl bank in a field adjoining the turnpike-gate, I have collected the same kinds of fossils as at Middleham; also *rostellariæ, auriculæ, scaphites,* &c.

Hamsey Marl Pits. The hillock, of which these pits present a vertical section, is insulated by the river Ouse. The quarries are situated on the north side of the church, and are about 25 feet high. The strata are slightly inclined, and vary from a few inches, to a foot or more in thickness; the indurated layers, are separated by intervening seams of a soft loose marl, of a dark colour. The face of the rock is traversed by innumerable crevices, which, in some instances, are parallel with the stratification, and in others assume a vertical, or transverse direction.

The lowermost strata are of a bluish grey colour, indicating a transition to the blue marl, into which the grey marl passes, at the depth of a few yards. These quarries contain sulphuret of iron, and spicular crystals of carbonate of lime; the former often composes the constituent substance of the fossils, the latter occurs in groups, lining the fissures and cavities in the marl. The organic remains found in these pits are very numerous, and present considerable interest. They consist of several species of *ammonites, nautili, turrilites, scaphites, hamites,* the teeth and vertebræ of sharks; the supposed fir cones of Cherry Hinton, &c.

Offham Pit. This excavation lies on the road-side, between Offham and Cooksbridge; it produces *ammonites, nautili, turrilites, scaphites,* &c.

Clayton, near Hurstperpoint. A marl pit at this place, has afforded to the researches of Mr. Weekes, *turrilites, hamites, ammonites, scaphites,* &c.

In other localities of the marl, the fossils are less abundant than in those above enumerated, and the *turrilites, hamites,* and *scaphites,* but very rarely occur.

On the surface, a narrow belt of this deposit appears to encircle Lewes Levels, separating the latter from the edge of the chalk hills; this want of continuity, however, does not extend beneath the surface: the marl is invariably found upon sinking through the alluvial clay, of which the Levels are composed. Protrusions of the marl through the clay occur in some situations, and these form islands when the levels are inundated, a circumstance that, previously to the improved state of the navigation of the Ouse, was of very frequent occurrence. The principal elevations of this kind are the two extended ridges called the *Rhies,* which have been already described; these, in all probability, owe their form to the action of eddies, or opposing currents.

Minerals.

The mineralogical productions of the grey marl are few, and offer but little variety; they consist of various modifications of sulphuret of iron, and crystallized carbonate of lime.

1. Crystallized carbonate of lime.

This mineral is frequently semi-diaphanous, varying in colour from a lightish grey to a gallstone yellow. It occurs in inconsiderable veins, and occasionally in groups of crystals, lining the cavities of the marl; the usual form of the crystal is that of an acute rhomboid; of this kind some interesting specimens have lately been discovered at Hamsey.

2. Sulphuret of iron, or iron pyrites.

This substance, from the decomposition of its surface, is generally of a yellowish rusty brown colour externally. It occurs in a variety of irregular fantastic shapes, and oftentimes bears the impression of organic bodies, forming casts of *terebratulæ, pectenites, madreporites,* and the inner volutions of *scaphites.* Small spherical masses with an elongated stem, their surface beset with obscure pyramidal crystals, and exposing a brilliant radiated structure internally, are not uncommon. One specimen in my possession contains within a cavity, small crystals of *sulphate of lime.*

Crystals of pyrites terminating in the quadrangular pyramid of an octohedron, and disposed in irregular groups, are often imbedded in the casts of ammonites, and other fossil remains; and the marl pits at Hamsey, contain masses of this mineral bearing the form of a species of *Eschara*, somewhat resembling *E. foliacea.*

3. Oxide of iron, in the state of a reddish brown powder, is frequent in cavities of the marl, and has probably been produced by the decomposition of iron pyrites; the greater part of the marl fossils have acquired a ferruginous colour from this mineral.

4. Clay slate. The occurrence of this substance in the marl is clearly accidental, having been derived from some regular bed of argillaceous slate of anterior formation to the chalk marl. The only examples hitherto discovered, were imbedded in the marl at Southerham Corner; the largest is about two inches square, and nearly half an inch thick: the edges are sharp, and the specimen appears to have suffered but little from attrition.

Organic Remains.

The grey chalk marl in its course through Sussex, is well characterized by its organic remains, which differ both in their nature, and in the mode of their preservation, from those either of the superincumbent bed of lower chalk, or of the blue marl upon which it reposes.

Numerous species of *ammonites, nautili,* and *inocerami,* are the most common productions of the pits near Lewes, which also contain *turrilites, scaphites, hamites,* &c. These remains of testacea very rarely exhibit any vestige of their original shelly covering, but consist of casts of indurated argillaceous limestone, of an ochraceous or a ferruginous colour, more or less distorted by compression.

1. Wood. The existence of fossil wood in the chalk formation has been much questioned by some geologists, but the fact is indisputable, as numerous examples in my collection satisfactorily prove. It is of a dark brown colour inclining to black, and when first collected, very distinctly

exhibits its ligneous structure. It is exceedingly friable, and falls into a carbonaceous powder upon exposure to the air.

The specimens found at Hamsey, seldom exceed a few inches either in length or breadth; they are of a compressed cylindrical form, and appear to be the remains of branches, or stems of small trees.

Locality. Hamsey.

2. Aments or cones of unknown vegetables?? Tab. IX. figs. 4, 5. 7, 8. 11.

Woodward's Catalogue, Part 2, p. 22. 6. 72. "Three cones, seeming to be of the larix."

Org. Rem. Vol. 1. Pl. 6. figs. 16, 17.

These are the supposed "*fossil juli of the larch*," for which the chalk pits of Cherry Hinton have been so long celebrated. Since the time of Woodward, these bodies have excited considerable attention, and yet their nature is still involved in obscurity; in fact, their appearance is so equivocal, that some naturalists have been induced to consider them as the remains of *animals*, rather than of vegetables.

Dr. Parsons thought they bore a greater resemblance to the roots of a plant, than to the parts of fructification.

A. B. Lambert, Esq. V.P.L.S., to whom I shewed a very perfect specimen, was immediately struck with its affinity to the cone of a species of pinus.

Mr. Parkinson supposes, "that the appearance of these fossils certainly supports the idea of their having been either aments or cones of some tree not now known, at least to the European botanist; whilst, on the other hand, the situation in which they occur, renders this supposition highly problematical. Instead of being associated with other fossil vegetables, or in matrices which have originated in the decomposition of vegetable matter, they have only been found in chalk, which has proceeded chiefly from aqueous deposition; and in part from the decomposition of animal, but certainly not of vegetable matter*."

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* *Organic Remains*, Vol. 1. p. 447.

Professor Hailstone informs us, that two perfect specimens in the Woodwardian collection, place their vegetable origin beyond all doubt, and in corroboration of this opinion, mentions, that in the quarry at Cherry Hinton, he had discovered the impression of a branch of some vegetable of the fir tribe, with the linear leaves surrounding it*.

On the other hand, Mr. Konig of the British Museum, who did me the favour to examine several Hamsey specimens, remarks, that "these bodies, although possessing a distant resemblance to the juli of the larch, in all probability do not belong to the vegetable kingdom; for when exposed to the action of muriatic acid, they emit the peculiar smell, which is so strikingly manifested, in dissolving the madreporitic remains of fetid limestone; the putrid exhalation being almost intolerable."

As these fossils occur in an excellent state of preservation in the marl pits at Hamsey, I had indulged the hope of being able to discover a specimen, that might illustrate their origin, and point out their real nature. But although by the kind assistance of my brother, more than fifty of these bodies have been submitted to my examination, I can add but little to what is already known concerning them.

The remains in question are of a reddish brown colour, from 0·5 inch to two inches long, of a cylindrical form, and gently tapering towards the apex, which is obtuse. They are more or less compressed, and have a scaly, corrugated surface. Their constituent substance is precisely of the same nature as that of the vertebræ, and other bones, found in the chalk formation; some examples have scales of fishes attached to them. In structure they differ most essentially from any strobilus or cone, for instead of an imbricated surface, formed by scales containing seed, and proceeding from one common axis, as in the juli of the larch, their scaly appearance is produced by the undulating margin of the substance of which they are composed; the latter being irregularly coiled in a spiral manner, round an oval cavity or receptacle. This appearance is very obvious in tab. ix. fig. 4, in which the marl is seen projecting through the interstices of the volutions; at the base of fig. 5, the termination of the last coil is distinctly exhibited. Fig. 7, is the longitudinal section of a fragment with the cavity or receptacle filled with marl: in some specimens this is wanting, the fossil being solid throughout. Fig. 8 is one of the most perfect examples that has been found in Sussex. The base is thicker, and of a darker colour, than the body of the fossil, and has much the appearance of a calyx. In another specimen, a depression in the centre of the base resembles the attachment of a stem. Fig. 11 is remarkably large, but has suffered considerably from compression.

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* *Geological Transactions*, Vol. 3. p. 250.

Locality. Hamsey.

3. Linear markings, the impressions of leaves? from Hamsey.

These resemble the chalk specimens delineated in tab. ix. figs. 2, 12, and have been supposed to be the foliage of a species of larch, of which the aments or cones, above described, were the fruit. This opinion is however problematical.

ZOOPHYTES.

The zoophytes of the chalk marl are neither numerous, nor important. They consist for the most part, of fragments of unknown genera, in which the characters of the original are too imperfectly developed, to allow of accurate determination:—a few of the more perfect specimens are here enumerated.

4. Small turbinated bodies, having a pedicle, the surface covered with circular pores or cells, irregularly disposed. These bear some analogy to the compound porpital madreporite, but their openings do not appear to possess a stellular structure. Their constituent substance is an earthy oxide of iron.

Localities. Hamsey marl-pits, Stoneham, &c.

5. Alcyonium ? *pyriformis.*

A pyriform body, composed of argillaceous limestone, about two inches long, the surface presenting a spongeous appearance:—resembling in form the alcyonitic flints figured by Mr. Parkinson, *Org. Remains*, vol. ii. tab. ix. figs. 4, 6, 12.

This fossil may be referred to the genus alcyonium, with less hesitation than many of the mineralized zoophytes, to which that name is usually applied.

Localities. Hamsey, South Bourne, near Beachy Head.

6. A cylindrical ramose zoophyte, about 0·4 inch in diameter, branches short, distinct, decussatedly opposite *; terminations obtuse, with a central depression.

The only specimen hitherto discovered possesses the structure here described, but more perfect examples are necessary to determine its characters. It approaches in some respects to Alcyonium *mammillosum*, and A. *ocellatum* of Ellis †.

Localities. A marl bank near Malling Gate.

7. Millepora.————? Tab. xv. fig. 10.

A ramose, subcylindrical zoophyte; branches distinct, opposite; terminations truncated, bilobed, with rounded entire margins, the centres oblong and depressed; cells irregularly rhomboidal, arranged in parallel rows.

The cells are but imperfectly shown, and it is scarcely possible to determine their original form with any degree of accuracy.

Locality. Marl bank at Stoneham; near the Rev. J. Constable's, Middleham.

8. Millepora *Gilberti*.

Foliaceous, flexuous, terminating in projections with oblong openings, each having an spinous obtuse process: surface covered with minute circular pores, irregularly disposed.

A very elegant milleporite, composed of crystallized carbonate of lime; not unfrequent in the localities hereafter mentioned. The short spinous projection, which proceeds from the margin of the terminations, appears to constitute its specific character.

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* *i. e.* arranged crosswise, in four rows.

† *Ellis' Zoophytes*, one volume, 4to. 1786, tab. i. figs. 4 and 5.

I have named this species in honour of Davies Gilbert, Esq. M. P. V.P.R.S., &c. of Eastbourne, a gentleman universally respected for his public talents, and beloved for the suavity of his manners, and the excellence of his private character.

Localities. In the cliff near Southerham, and Beachy Head.

9. A flexuous zoophyte, occurring in masses of an oval form, from two to five inches in length.

These fossils bear some affinity to the preceding, but those in my possession do not exhibit any traces of pores, or cells. They have been supposed to belong to the genus Spongia, but more illustrative examples are required to establish the conjecture. Their constituent substance is calcareous spar.

Localities. In the beds of marl that form a junction with the grey sand, at Southbourne.

10. Portions of a foliaceous zoophyte, allied to the genus Flustra, the surface covered with small, ovate, symmetrical openings, disposed in meshes.

Localities. Stoneham, Middleham.

ECHINITES.

The echinites of the grey marl have their characters but imperfectly defined, and are extricated from the surrounding matrix with great difficulty. Their crustaceous coverings are invariably converted into a brittle crystallized carbonate of lime, and their cavities filled with marl; they are generally distorted by compression.

11. Cidaris. Tab. xvii. fig. 1.

Circular, depressed, with ten porous ambulacra, and as many areæ. The surface is covered with twenty rows of small, elegant, perforated papillæ, set on tubercular projections, the margins of which are crenulated.

This fossil appears to be a variety of Echinocidaris *saxatilis.*

Localities. Hamsey, Offham.

12. Echinospatagus *cordiformis* (of *Breyn.*)

An oblong, cordiform echinite, exceedingly common in the chalk, but of rare occurrence in the marl.

Localities. Hamsey, Middleham, Eastbourne.

13. Echinospatagus *radiatus? Organic Remains*, vol. iii. tab. iii. figs. 4 and 5.

An ovate galeated echinite, very closel allied to the species referred to.

Localities. Hamsey, Middleham.

14. Echinital spines.

Slender muricated spines, the *cucumerinæ* of Parkinson, are occasionally found at Hamsey; and I have one specimen of a palisadoe spine from the same place, which possesses a spathose structure.

TESTACEÆ.

Univalves.

15. Voluta *ambigua*, tab. xviii. fig. 8.

Although the specimen here figured is merely a cast of the venter, or lower volution of the shell, its characters are sufficiently obvious to identify it with V. *ambigua* of the London clay. It is attached to a portion of Ammonites *varians.*

Locality. Middleham.

16. Buccinum, tab. xviii. fig. 13.

The cast of the last wreath of a ventricose univalve, belonging to this genus, is the only example that has come under my notice.

Locality. Hamsey.

17. Rostellaria *Parkinsoni*, tab. xviii. figs. 1, 2, 4, 5, 6, 10.

Subfusiform, wreaths seven or eight, convex, with longitudinal ribs, and numerous transverse striæ; outer lip dilated, armed with one styloid process, beneath which is a broad truncated expansion. This species occurs in the green sand of Devonshire, and is figured in the third volume of "*Organic Remains*," plate 5, fig. 11. As it has not received a specific appellation, I have named it after my excellent friend James Parkinson, Esq. M.G.S. &c. of Hoxton Square, the learned author of the "*Organic Remains of a former World.*"

The specimens figured, although differing from each other in certain particulars, are evidently casts of the same species; the differences observable arising partly from compression, and from the markings of the original shell being more strongly impressed in some examples, than in others.

In figures 1 and 5, which are different views of the same specimen, the wreaths are nearly smooth, with the exception of a few imperfect costæ.

Figures 2 and 4, are nearly flat from compression, and the ribs almost effaced, but the surface is covered with transverse striæ. The collection of the Geological Society contains a large specimen of this kind.

Fig. 6. A cast of five wreaths, including the venter; but the outer lip and base of the columella are not preserved. In this example the upper volutions are smooth; the two lowermost exhibit the ribs and striæ.

Fig. 10. Represents a cast of the dorsum, or back of the shell; but the base of the largest wreath is unfortunately destroyed. In this specimen the ribs and striæ, with the styloid process of the outer lip, are well defined.

Localities. Hamsey, Middleham, Southbourne, Ranscombe.

18. Trochus ———? Tab. xviii. fig. 7.

The outline of this delicate cast resembles that of *Trochus agglutinans* of Brander.

Locality. Hamsey.

19. Trochus ———? Tab. xviii. fig. 9.

Discoidal, base slightly convex, the margin acutely angular, aperture—?

The base of the shell delineated in the figure, is the only portion I have seen; the angular margin is a remarkable character by which this species may be readily identified*.

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* In a specimen of *Trochus agglutinans*, from Grignon, recently presented me by M. Brongiart, the outer margin of the last whorl very closely resembles that of the present fossil.

Locality. Hamsey.

20. Trochus *linearis*, tab. xviii. fig. 17.

Conical, wreaths slightly convex, transversely striated, with a prominent line along the centre and base of each volution; base flat; umbilicus obscured by the last volution; aperture transversely depressed.

In figure 17, the linear markings, by which this species is distinguished, are but obscurely shown; but in a specimen subsequently discovered, and which contains a portion of the original shell, these characters are strongly marked.

Localities. Hamsey, Middleham.

21. Trochus, ———— tab. xviii. fig. 16.

The cast of a species of trochus of an oval form; probably of T. *linearis*, distorted by compression.

Locality. Hamsey, Middleham.

22. Auricula *incrassata*, tab. xix. figs. 2, 3. 34.

Ovate, ventricose, transversely sulcated; sulci longitudinally striated; spire short; columella triplicated; outer lip thick, with a broad transversely striated border.

The three folds on the columella, the striated sulci, and the broad band on the margin of the external lip, are the distinguishing marks of this beautiful shell. It is a small species, consisting of about three volutions, and seldom exceeds half an inch in length, by 0·3 inch in width. The spire is short, the outer lip thick; the broad striated band gives a peculiar feature to the back of the shell. The striæ which cross the delicate grooves or sulci, are so minute, as scarcely to be visible to the naked eye. When viewed with a lens they appear elevated and sharp, dividing the furrows into minute rectangular cells. This species occurs silicified in the Blackdown whetstone pits of Devonshire, and is described by Mr. Parkinson. Mr. Sowerby mentions that "it resembles A. *ringens* of Lamarck, but the want of striæ within the outer lip, and the presence of longitudinal striæ upon the surface, distinguish the British shell."

Fig. 2. is an elegant specimen, in which the shell is replaced by a thin pellicle of reddish brown sulphuret of iron, upon a cast of indurated marl.

It shews the plicated folds of the columella, and the broad band of the outer lip.

Fig. 3. A smooth cast, in which the spire is more produced than usual.

Fig. 34. A large specimen, exhibiting the back of the shell.

Tab. xviii. fig. 3. is a distorted cast, that bears a closer affinity to *Auricula simulata* of Sowerby, (*Min. Conch.* tab. 163, figs. 5. 8.) than to the present species.

Localities. Hamsey, Middleham, Stoneham, Offham.

23. Ampullaria? Tab. xviii. fig. 11.

The cast of a subglobose, ventricose, univalve, probably belonging to the genus Ampullaria:—the depressions of the spire, and the oblique form of the cast, originate from compression.

Locality. Hamsey.

24. Vermicularia *umbonata*. Tab. xviii. fig. 24.

Discoidal, spire depressed, concave beneath, umbonated above; the outer volution produced, and marked with distant, annular ridges.

This species is commonly about 0·7 inch in diameter, and consists of two or three volutions. It is slightly concave, or umbilicated, on its inferior surface, the inner whorls of the upper sides being concealed by an umbo. The produced part frequently exceeds in length the longest diameter of the shell, and is marked with sharp annular ridges; where these occur, the substance of the shell is much thickened, the cavity of the tube being diminished nearly one-third. The aperture is simple, and round.

Fig. 24. This example shows the depressed spire with its central obtuse knob, and a considerable portion of the produced part of the external volution. In every specimen of this fossil the shell, hardened by an impregnation of calcareous spar, still remains.

Locality. Hamsey.

25. Vermicularia *Sowerbii*. Tab. xviii. figs. 14, 15.

Conical, spiral, smooth, umbilicate, inner wreaths anchylosed, slightly inserted; aperture indented by the preceding volution; outer whorl not produced?

This species differs from V. *umbonata*, in having the spire elevated and the whorls inserted; the outer volution is not produced in any specimens yet discovered. The line of separation between the wreaths, is obscured by an extension of the substance of the shell, by which the volutions are anchylosed, or cemented together.

The specific name is in honour of James Sowerby, Esq. F.L.S. &c. whose indefatigable exertions have very materially contributed to the elucidation of the Natural History of the British Islands.

Locality. Hamsey marl-pits.

26. Serpula.

A small group of serpulæ have been discovered at Hamsey, by Mrs. Mantell. The shell is smooth, and very tortuous, bearing some analogy to S. *glomerata;* but is probably a distinct species.

27. Nautilus *elegans*. Tab. xx. fig. 1. tab. xxi. figs. 1. 4. 8.

Subglobose, umbilicate, transversely sulcated; sulci numerous, linear, curved, reflexed; volutions one-third inserted; septa concavo-convex, entire; siphunculus central; aperture obtusely sagittate.

The thickness of this nautilus is equal to twice its width. The sulci are transverse, and very numerous, dividing the surface into broad, flat costæ; these form an elegant curve on the back of the shell, and proceeding laterally, are reflected towards the umbilicus. The septa are gently undulated, and have their convex surface placed in an opposite direction to that of the sulci, which they decussate. The siphunculus is large and nearly central, and the umbilicus very small. In a young state the sulci are wide, and separated by sharp transverse ribs, the whole surface being marked by numerous longitudinal striæ.

Casts of this species are common in the grey marl of Sussex, and Wiltshire, but no vestiges of the shell itself have been observed. The pecimens are frequently oblique from compression, and seldom exhibit the curved sulci in perfection; they are from one to twelve inches in diameter.

Tab. xx. fig. 1. is a remarkably fine cast of an adult shell, in which the sulci, with the broad and flat costæ, the situation of the siphunculus, and the form of the septa or dissepiments, are well preserved. It was discovered in a marl bank at Middleham, in the winter of 1814.

The following are casts of the young shell.

Tab. xxi. fig. 1. Nearly smooth, the spire oblique, and much compressed.

——— fig. 4. In this example a few linear sulci, and the markings of the septa, are the only indications of the species.

——— fig. 8. This very elegant and perfect cast is from Middleham. It is deeply channelled by the broad transverse sulci, and is an excellent example of the characters of the young shell.

The small smooth Nautili so frequently met with in various localities of the marl, are imperfect specimens of N. *elegans* in a young state. In a few instances the septa are composed of sulphuret of iron, and the chambers lined with crystals of carbonate of lime.

Localities. Hamsey, Stoneham, Offham, Middleham, Ranscombe, Firle, &c.

28. Ammonites *Mantelli* (of Sowerby.) Tab. xxix. fig. 9. Tab. xxii. fig. 1.

Discoidal, subumbilicate: volutions subrotund, costate, one-third inserted; costæ tubercular, transverse, alternately annular, with from two to eight rows of tubercles; ambit flattish, with two rows of marginal tubercles; septa very sinuous; siphunculus external.

The number and disposition of the ribs and tubercles of this species are so various, that although it is one of the most abundant productions of the grey marl, its specific characters are not easily defined.

The general form of the shell is discoidal, the volutions (which when perfect are nearly cylindrical,) being flattened by compression, as in the specimens figured by Mr. Sowerby. The inner wreaths, in those which are compressed, are nearly two-thirds concealed, but in more perfect examples are less deeply inserted. The costæ are round, and extend alternately across the whorls, the intermediate ones embracing about two-thirds of the volutions. The tubercles constitute the following varieties.

Var. costata: with two rows of tubercles, tab. xxi. fig. 9. Two tubercles are placed on every rib, and form a row on each margin of the ambit, or back, of the shell.

Var. tuberculo-costata: with six rows of tubercles. This variety, in addition to the marginal tubercles, has four rows, which are placed on the longer costæ only; each side of the shell having one set on the margin of the umbilicus, and another at a short distance above it.

Var. tuberculata: with eight rows of tubercles. The two additional sets which distinguish this variety, are placed one on each side, midway between the margin of the ambit, and the second row of tubercles from the umbilicus. These intermediate tubercles occur on every rib, each of the larger costæ being ornamented with eight, while the shorter ones have but four. From the numerous tubercular projections on this variety, the outer volution is somewhat pentagonal.

The septa of A. *Mantelli* are numerous, and very foliaceous. The form of the aperture varies in different specimens, but its width is in general equal to about two-fifths of the diameter of the shell. The siphunculus is small, and extends along the centre of the ambit.

This species frequently attains a large size, some specimens exceeding one foot and a half in diameter; but in these the tubercles are almost obliterated.

Tab. xxi. fig. 9. A beautiful cast, from Middleham, of the first variety.

Tab. xxii. fig. 1. This specimen also belongs to *Var. costata* *: it exhibits the foliaceous septa, and the situation of the siphunculus. It was collected by my friend, Thomas Woollgar, Esq. of Lewes.

Localities. In almost every spot in Sussex, where an excavation has been made in the grey marl.

29. Ammonites *Sussexiensis*. Tab. xx. fig. 2. tab. xxi. fig. 10.

Discoidal, subumbilicate: volutions subquadrangular, inserted, costated; costæ transverse, numerous, with seven rows of tubercles, one of which extends along the centre of the ambit; septa foliaceous; siphunculus ——— ?

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* The plates of this work were completed before any illustrative specimens of the other varieties had been discovered.

This species is nearly allied to the preceding, but is distinguished by the ribs in almost every instance, reaching entirely across the volutions; and by the central row of tubercles on the ambit.

The sides are flattish, the external margin somewhat angular, the ribs prominent, in most instances entirely embracing the volutions, but in some varieties being alternately short, as in A. *Mantelli*. They are studded with seven sets of tubercles, arranged in the following manner; viz. a row on the inner and outer margins, with two intermediate ones on each side; and a dorsal row along the ambit. The aperture is nearly quadrangular; and the septa foliaceous. The situation of the siphunculus is unknown.

In the adult shell the ribs are prominent, and somewhat angular, the dorsum broad and flat, and the central row of tubercles almost obliterated.

This beautiful species varies from a few inches to a foot in diameter, and was formerly abundant at Hamsey, but is now seldom found.

Tab. xx. fig. 2, represents a specimen of the size and form in which this species most usually occurs.

Tab. xxi. fig. 10. A perspective view of a small specimen.

Localities. Hamsey, Offham, Middleham, Southerham, Rodmill, Plumpton.

30. Ammonites *varians*. Tab. xxi. fig. 2. 5. 7.

Discoidal, subumbilicate, volutions depressed, half inserted; transversely radiated; radii bifurcate, undulated, studded with from four to six rows of tubercles; septa very foliaceous; carene acute, entire; aperture sagittate; siphunculus external?

This species of ammonite is one of the most proteiform of the whole genus, presenting great variety in the figure, disposition, and number of the tubercles and costæ. It is, however, readily distinguished from its associates, by the acute entire keel, and the bifurcating tubercular radii.

It is from 0·2 inch to nearly six inches in diameter, and is frequently compressed into an elliptical, and sometimes into a cordiform shape. The volutions seldom exceed four in number, and are rather more than half inserted. The umbilicus is shallow and expanded, its sides smooth, and crested with a row of small tubercles, from which the radii arise. The latter proceed obliquely over one-fourth of the volutions, where they form another set of tubercles, from whence they diverge into two branches, each terminating in a tubercle on the outer margin. The carene is smooth, and forms a prominent acute keel, having a row of *opposite* tubercles placed on each margin.

In a suite of fifty specimens, in which every individual presented some peculiarity, three principal varieties were observable, each passing insensibly into the other.

Var. subplana. Tab. xxi. fig. 2.

The volutions depressed, radii linear, inner row of tubercles obscure, external margin crenated, keel but slightly elevated, aperture sagittate.

Some specimens of this variety are nearly smooth, and the keel so much compressed, that without the aid of numerous examples, their relation to the tubercular variety could not have been ascertained.

Var. intermedia. Tab. xxi. figs. 7, 8.

In this variety the volutions are rather depressed, the radii broad and well defined, the tubercles small and distinct, the external margin tuberculated, the keel prominent, and the aperture sagittate.

This is the usual form of the species, and holds an intermediate rank, between the smooth and tubercular varieties.

Var. tuberculata. Min. Conch. Tab. clxxvi. figs. 1, 2, 3, 4. 6.

Volutions subrotund; radiations short, thick, nodular; tubercles elongated, very prominent; keel acute; aperture roundish.

A very beautiful variety, distinguished by its projecting tubercles, of which Mr. Sowerby's figure 1, affords an excellent example. The inner rows of tubercles are almost effaced, but the marginal and intermediate sets are strongly relieved, and in some examples become spinous. From the thickness of the volutions, the aperture is obovate.

Localities; very abundant at Hamsey, Middleham, Stoneham, &c.

31. Ammonites *cinctus.*

Dicoidal, subumbilicate, volutions depressed, half inserted, transversely radiated; radii annular, distant, bifurcate, undulated; umbilicus expanded, sides smooth, with a marginal row of oblique tubercles; ambit convex, embraced by the radii; aperture ovato-sagittate.

The volutions, although compressed, have a slight degree of convexity, and are ornamented by transverse radiations, that arise from a row of small tubercles on the inner margin. Each radius divides into two branches, which pass with a gentle sweep across the ambit, and unite with the corresponding undulations of the opposite side; small oblique tubercles are placed on each radius at the point of bifurcation. The volutions are three in number, the inner ones being three-fourths concealed. The dorsum, or ambit, is gently undulated by the radii.

But one specimen has been discovered, the dimensions of which are as follows: longest diameter 3·8 inches; width of the outer volution, two-fifths of the diameter: transverse diameter of the aperture 1·1 inch.

It is scarcely necessary to remark, that although this species approaches to *A. varians*, in having bifurcating radiations, and a row of tubercles on the inner margin, yet it is widely separated from it by the rounded form of the back, and other obvious differences.

Locality. Middleham.

32. Ammonites *falcatus*. Tab. xxi. fig. 6. 12.

Depressed, subumbilicate, volutions deeply inserted, transversely radiated; radii plicated, falciform, extending down the sides of the umbilicus; umbilicus small, with crenulated edges; dorsum flat, narrow, with a longitudinal sulcus; margin plicated; aperture sagittate, siphunculus ——— ?

This rare and elegant species is almost flat, the longest diameter exceeding its greatest thickness nearly four-fifths. The volutions are slightly enlarged in the centre, but are contracted at the ambit into a narrow flat keel, with a sulcus down the middle, and delicate plicated edges. The radii are very slender at their origin in the umbilicus, but gradually increase in breadth, and passing obliquely to the centre of the volutions, make a sudden curve towards the margin, where they terminate in obtuse folds. The form of the septa, and the situation of the siphunculus, are unknown.

The shape of the radii is so remarkable, that the species may be readily identified.

Tab. xxi. fig. 6, the only perfect cast hitherto discovered: from Middleham.

——— fig. 12. A fragment from Stoneham, exhibiting the flat sulcated ambit.

Localities. Middleham, Stoneham.

33. Ammonites *curvatus*. Tab. xxi. fig. 18.

Depressed, subumbilicate, volutions deeply inserted, transversely radiated; radii falciform, bifurcate at the commencement, terminating in broad, tubercular curved costæ; carene with a longitudinal sulcus, between two marginal rows of tubercles; aperture obtusely sagittate.

This ammonite is nearly allied to the preceding, but is evidently a distinct species. In *A. falcatus* the *curvatures* are more *numerous* than the *oblique radii;* but in the present species, the proportions are reversed, *two or three radii* uniting to form *one* curved rib. The terminations of the ribs in the latter are tubercular, and separated from each other by a sulcus; in the former they are gently curved, and appear as if folded or plaited over each other.

The umbilicus is rather deeper than in *A. falcatus*, and has a marginal row of oblique tubercular projections, from each of which two or three radii proceed to the centre of the volutions; here they unite, and form a broad curved rib, that terminates in an elongated tubercle in the margin of the ambit. Another tubercle is placed on the middle of the curved part. The keel is grooved, and has two rows of prominent, distinct, opposite tubercles, formed by the termination of the ribs.

Locality. Hamsey. The specimen figured was discovered by my brother, and is unique.

34. Ammonites *complanatus*.

Flat, volutions wholly inserted, the inner half marked with numerous, indistinct, transverse undulating striæ, the outer portion plicated; umbilicus very small, almost concealed; carene slightly convex, its margins crenated by the angular terminations of the plicæ; aperture slightly sagittate; siphunculus ——— ?

The longest diameter is about 8 inches, greatest thickness 1·8 inch, width of the outer volution 5 inches.

The volutions are thickest near the middle, and gradually contract into a narrow keel, which at the aperture, does not exceed 0·4 inch in width, and has an elevation or ridge down the centre. The plicæ are small, and extend from the outer margin over one-third of the wreath, but the intermediate ones do not reach beyond half that distance: their terminations are angular, and form a crenated border on each side the keel.

This species may be distinguished by its flatness, the great width of the outer volution, the small conical umbilicus, the narrow keel, and the angular plicæ.

The septa are numerous, and very foliaceous.

Locality. Hamsey.

35. Scaphites *striatus.* Tab. xxii. figs. 3, 4, 9, 11, 13, 14, 15, 16.

Volutions transversely striated; striæ numerous, oblique, annular, bifurcate; dorsum tumid; aperture produced, transversely ovate, marginate; siphunculus internal?

This species is commonly about an inch in length, the greatest thickness is 0·4 inch, width 0·8 inch. The inner whorls are umbilicate, deeply inserted, and wholly concealed by the outer volutions. The dorsum is suddenly enlarged, and the reflected turn terminates before it reaches the centre. The aperture is entire, of an irregular ovate form; the margin prominent, the upper part produced, extending a little over the spire. The whole shell is striated; the striæ arise singly from the inner margin, and dividing into two or three, pass over the dorsum, and unite with the corresponding ones of the opposite side. The inner half of the outer volution is somewhat depressed, and from thence the striæ extend obliquely in a radiating manner, and bifurcate at the edge of the depression; towards the aperture of the shell, the striæ are larger and more distinct. The septa are but slightly concave, and their edges have three principal indentations, with several minute sinuosities. The situation of the siphunculus is unknown, but appears to have been on the internal margin.

The specimens consist of indurated marlaceous casts, occasionally possessing portions of the shell. The inner volutions are often filled with sulphuret of iron, and sometimes with calcareous spar. In almost every instance, the spire is more or less oblique, and otherwise distorted by compression: the variations of shape observable in the specimens delineated, have evidently been produced by this cause.

Tab. xxii. fig. 3, a dorsal, and fig. 4, a lateral view of a Scaphite from Hamsey, flattened by compression.

Fig. 9, exhibits the obliquity of the spire: a straight specimen, in my possession, proves that this appearance is the effect of accident.

Fig. 11, exhibits the usual characters of the species; the aperture is broken off.

Fig. 13, a specimen from Ranscombe, remarkably distorted.

Figs. 14, 15, different views of a pyritous cast of the inner volution: the dark spot in the centre of fig. 14 shews the supposed situation of the siphunculus.

Fig. 16, is a longitudinal section; the inner chamber is filled with dark brown sulphuret of iron.

Localities. Hamsey, Rodmill, Brighton.

36. Scaphites *costatus*. Tab. xxii. figs. 8, 12.

Volutions convex, laterally compressed, transversely striated, inner whorls concealed, inserted; striæ furcate, numerous, embracing the ambit: sides of the outer volutions smooth, with eight or ten distant, oblique, nodular projections; dorsum broad, convex.

This is a less delicate shell than the former; its length is 1 inch, width 0·8 inch; thickness of the back 0·6 inch. It is distinguished from S. *striatus* by the nodular projections on the sides of the external volutions. These proceed from the centre, and diverge into numerous striæ, which encircle the ambit. The back is broad, and the projecting terminations of the striæ give its edges an undulated appearance. The aperture is oblong, and fronts the spiral part.

Localities. Hamsey: very rare.

37. Hamites *armatus*. Tab. xxiii. figs. 3, 4. Tab. xvi. fig. 5.

Depressed, ornamented with oblique annular costæ, and four rows of tubercles, the marginal ones spinous; siphunculus external? limbs straight, parallel.

The characters of this beautiful Hamite were first developed by a gigantic specimen found in a marl-pit at Roach, near Benson, in Oxfordshire, by Professor Buckland, and figured in *Min. Conch.*; previously to this discovery, fig. 4 was the finest example extant. The casts of the shell only remain, and the spinous processes are in consequence but rarely preserved. The form of the original was in all probability cylindrical, but the fossil specimens are in some degree flattened and distorted. The limbs are straight, the hook or bend being very sudden. There are generally one or two costæ between each annular row of tubercles, and the latter embrace two or three ribs. The spines are only known to proceed from the two dorsal rows of tubercles; but it seems probable, that the other tubercles are also the rudiments of spinous processes, since all of them are imperfect, and appear as if broken off. The septa are very foliaceous.

Tab. xvi. fig. 5, is a fine fragment from Hamsey; traces of the foliaceous septa are visible at the fractured part.

Tab. xxiii. fig. 3. View of one of the septa, or chambers, shewing its foliaceous structure.

——— fig. 4. This fine specimen has already been noticed; it is so much distorted by compression, that only two rows of tubercles are seen in this view: it was discovered at Hamsey by my brother.

Localities. Hamsey, Middleham: rare.

38. Hamites *plicatilis*. Tab. xxiii. figs. 1, 2.

Subcylindrical, with numerous, oblique, annular ridges, and four rows of spines: limbs curved.

The curvature of the limbs distinguishes this species from the one above described, with which however, it closely corresponds in every other particular.

Tab. xxiii. fig. 1, is the only specimen yet discovered, in which the spines remain; they are composed of a thin pellicle of reddish brown sulphuret of iron, that has replaced the original shell. This example is part of the lesser limb, broken off near the curvature; it is inverted in the engraving.

——— fig. 2, part of the larger limb, shewing traces of the foliaceous septa.

Localities. Hamsey, Middleham: very rare.

39. Hamites *alternatus*. Tab. xxiii. figs. 10, 11.

Subcylindrical, with oblique annular costæ, and two rows of tubercles; tubercles marginal, placed on each alternate costa; curvature gradual.

I have seen but one fragment of this species, which, except in size, agrees with H. *spinulosus* of Sowerby, the tubercles being in all probability the bases of spines; it is however impossible to determine their identity without more perfect examples.

The specimen is elliptical from compression; the ribs are very distinct on the sides and back, but almost obliterated on the inner margin. The tubercles are placed on each alternate rib, a circumstance that separates this species from the other spiniferous hamites, previously described.

Locality. Middleham.

40. Hamites *ellipticus*. Tab. xxiii. fig. 9.

Depressed, surrounded by even, undulating ridges, each ornamented with two small tubercles placed on the outer margin; curvature elliptical.

This hamite appears to be identified by its even undulating ridges, each furnished with two tubercles, and the elliptical form of its curvature. It must however be acknowledged, that there is considerable difficulty in distinguishing the essential characters of a fossil, from the variations that are produced by age or accident, particularly when only a single specimen is known.

Locality. Middleham.

41. Hamites *attenuatus?* Tab. xxiii. figs. 8. 13.

This species has already been described as occurring in the Blue Marl. (Vide Blue Marl Fossils, No. 21.) The specimens here figured are nearly cylindrical, and covered with oblique annular striæ; it is however doubtful whether they belong to the species referred to.

Tab. xxiii. fig. 5, is the fragment of a very large hamite, nearly allied to the preceding; it was collected at Hamsey by Mrs. Mantell.

Localities. Hamsey, Middleham, Stoneham.

42. Hamites *baculoides*, Tab. xxiii. figs. 6, 7.

Cylindrical, elongated, marked with obscure, oblique, distant undulations on the outer margin; curvature——? septa distant.

Fragments from one to six inches in length, and about 0·4 inch in diameter, marked with oblique undulations, and occasionally exhibiting foliaceous septa, are very abundant in every locality of the grey marl near Lewes: those figured are the most perfect that have yet been discovered.

This species may be easily recognized by its extraordinary length, by the smoothness of its surface, and the great obliquity of the few undulations with which it is ornamented. The form of the curvature is unknown; for although several hundred specimens have been examined, the short fragment delineated in fig. 6, tab. xxiii. is the only known instance of a deviation from a straight line. These remains are associated with fragments of a large size, almost cylindrical, and perfectly smooth: are these portions of the larger limbs of the same species? By an inadvertence, the specimens are represented in the plate, with the largest extremity downwards.

Localities. In every marl-pit in the south-eastern part of Sussex.

42. Turrilites* *costatus*. Tab. xxiii. fig. 15, Tab. xxiv. figs. 1, 4, 5.

Volutions reversed, convex, ornamented with transverse ribs, beneath which are two rows of tubercles.

The upper half of each wreath is ornamented with about twenty smooth, rounded costæ, beneath which is a row of elliptical tubercles, and a set of smaller ones on the inferior margin; the latter are partly obscured by the next whorl. In almost every example the costæ, and tubercles, pass into each other.

The specimens that occur in Sussex, very rarely exceed three or four volutions, and are always in some degree compressed; they are from one to seven inches in circumference, and from three to five inches long; the lowermost volution is but rarely preserved, and no traces of the shell remain.

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* Turrilites. A spiral, turreted, multilocular univalve; volutions contiguous and apparent; septa foliaceous, pierced near the upper margin by a siphunculus, aperture round; columella smooth.

Tab. xxiii. fig. 15, represents a specimen with part of the lowermost volution.

Tab. xxiv. figs. 1, 4, 5, exhibit the usual varieties of this species: in figures 4 and 5, the union of the ribs with the tubercles is distinctly shewn.

Localities. Hamsey, Clayton.

43. Turrilites *undulatus*. Tab. xxiv. fig. 8, Tab. xxiii. figs. 14. 16.

Volutions reversed, ornamented with prominent transverse costæ.

This species was first noticed and described by the author. It is characterized by its prominent transverse costæ, which are undulated in some examples, and extend directly across the whorls in others. In many specimens the ribs are oblique, and somewhat tubercular, a circumstance that has led some naturalists to question the correctness of considering the present species as distinct from T. *costatus*. In the casts of the adult shell, the characters of the two species are however distinctly marked, and leave no doubt of the propriety of their separation.

The *Turrilites undulatus* attains a larger size than the preceding, sometimes exceeding three inches in diameter.

Tab. xxiv. fig. 8, represents a very perfect example. It consists of eight volutions, including the lowermost, and exhibits the rounded base of the columella. On the opposite side, the siphunculus, filled with sulphuret of iron, is beautifully shewn. To my brother, Mr. Joshua Mantell, whose kindness I have had repeated occasions to acknowledge, I am indebted for the possession of this interesting specimen.

Locality. Hamsey.

44. Turrilites *tuberculatus*. Tab. xxiv. figs. 2, 3, 6, 7.

Volutions reversed, beset with a longitudinal row of nodular projections, beneath which are three rows of tubercles; inferior surface of the wreaths radiated.

This species is the largest of the genus. De Montfort mentions a specimen found at Rouen, which measured nearly a foot and a half in length; and one found by the author, at Middleham, is of much larger dimensions.

A row of from fifteen to sixteen obtuse rounded tubercles, are disposed round each volution, at about one-third from the superior margin, and beneath these are placed three sets of smaller tubercles. The inferior surface of the whorls is marked with radiating costæ, that terminate in the lowermost row of tubercles. The siphunculus is placed midway between the larger projections, and the upper edge of the wreaths, which is impressed by the ribs of the preceding volution. The base of the aperture is contracted, and the tubercles on the body of the last whorl are elongated, forming irregular tubercular costæ, which are reflected towards the aperture.

The fossil discovered by De Montfort "appears to have been in such a state of perfection, as to allow of its form being made out completely. It is regularly formed into a spire, the whorls of which are projecting and articulated, the foliaceous sutures produced by the edge of the septa being apparent. The opening of the shell is nearly round; the columella flat without any folds; and the septa perforated nearly in the centre, by a syphon *."

The magnificent British specimen of this species, previously alluded to, was found in a bank of marl, near the mansion of the Rev. J. Constable, at Middleham, in the parish of Ringmer. It is a cast of indurated marl of an ochraceous colour, retaining in one part a thin iridescent pellicle of the pearly coat of the shell. Six volutions remain, the largest of which is five inches and a half in diameter. Upon a moderate calculation, the original, when perfect, must have exceeded two feet in length. The siphunculus is exhibited on the three upper volutions †.

Tab. xxiv. fig. 7. A remarkably fine cast from Middleham.

The siphunculus, shewn in the three upper volutions, does not exist in the specimen, but is introduced here that the subject may be more fully illustrated.

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* *Organic Remains*, Vol. iii. page 147.

† This specimen is figured in Sowerby's *Mineral Conchology*, tab. lxxiv.

Tab. xxiv. fig. 6. Perspective view of a cast placed in an inverted position, to shew the radiated costæ on the base of the volutions.

Localities. Middleham, Stoneham.

It is worthy of remark, that this is the only species found in these localities, while at Hamsey and Offham, where the T. *costatus*, and T. *undulatus*, are met with, the present species does not occur.

BIVALVES.

The bivalves of the grey chalk marl so rarely exhibit any traces of the hinge, that their generic characters are but seldom distinguishable. The following are determined with as much accuracy as the imperfect state of the specimens would admit.

45. Arca. Casts of a small species, about 1·2 inch wide, and 0·7 inch long, have been discovered at Middleham; the surface is marked with fine, concentric, transverse striæ.

46. Venericardia? *Min. Conch.* Tab. 259.

This is a small species, with diverging longitudinal striæ, and is figured by Mr. Sowerby.

Localities. Middleham, Stoneham.

47. Astarte. A minute species, covered with transverse striæ.

Locality. Middleham.

48. Avicula. A thin delicate species, allied to *Avicula media, Min. Conch.* Tab. 2.

Locality. Hamsey.

49. Venus? *Ringmeriensis*, Tab. xxv. fig. 5.

Suborbicular, with numerous transverse concentric striæ, beaks incurved, approximate; margin entire.

The fine cast here represented, contains no vestige of the shell, and the structure of the hinge is in consequence unknown; as a temporary distinction I have referred it to the genus Venus.

Locality. Middleham; *unique*.

50. Cardium? *decussatum*, Tab. xxv. fig. 3.

Valves longitudinally costated; costæ radiating, decussated by concentric, transverse striæ, and sulci; posterior side truncated, cordiform; anterior side produced; beaks incurved.

This species, in its general form, approaches *Cardium hibernicum* (*Min. Conch.* tab. 82, figs. 1, 2.) but is distinguished by its numerous transverse sulci, the absence of the central protrusion, and by the posterior side being crossed by diverging striæ.

The length of this cast rather exceeds its width. The margin of the posterior side is raised, and a gentle depression is in consequence formed round the centre, which is somewhat elevated. The termination of the anterior side is unknown; the dotted outline in the figure indicates its probable form. The beaks are small and incurved.

The longitudinal ribs pass in a radiating manner, from the beaks to the margin; but are not visible on the posterior side. The sulci by which they are decussated, arise from the depression beneath the beaks, from whence they diverge across the posterior area, and becoming concentric, terminate on the edge of the anterior slope. The margin of the valves is entire.

Tab. xxv. fig. 3. A cast from near Brighton. The shell itself is unknown.

Localities. Brighton, Hamsey, Middleham, Offham.

51. Pecten *Beaveri.* Tab. xxv. fig 11.

Depressed, suborbicular, with diverging longitudina costæ; ears nearly equal to the width of the shell; margin irregularly undulated.

The costæ are about twenty in number, and diverge from the centre of the hinge to the margin. The ears are almost equal to the transverse diameter of the shell.

This species is from 2·5 inches to 3 inches in length, and is commonly in a good state of preservation.

In almost every example the internal surface only is exposed, the shell being attached to the marl by the outer side; in a small portion which I separated, the external surface was rugous, a circumstance that explains the cause of its adherence to the surrounding matrix.

The specimen figured is from Hamsey; it shews the inner surface.

Localities. Southerham, Beachy-head, Hamsey, Ringmer.

52. Pecten *triplicata*. Tab. xxv. fig. 9.

Subtriangular, longitudinally striated, with three deep, longitudinal furrows, which form angular plicæ on the front; margin crenulated.

Although but one valve of this elegant little Pecten has been discovered, its characters are sufficiently remarkable to warrant a specific appellation. The surface is furrowed by three deep sulci, that diverge from the hinge towards the margin, where they terminate in acute, angular plicæ. The shell is covered with minute longitudinal striæ, decussated by transverse lines of growth. The margin is thick, and delicately crenated.

Locality. Hamsey. The shell itself remains, and appears to have undergone but little change.

53. Pecten *quinquecostata?* Tab. xxv. fig. 10.

In many particulars, this beautiful shell resembles the flat valve of P. *quinquecostata**; but it is much more elongated, and may probably belong to a distinct species.

Locality. Hamsey.

54. Pecten *laminosa*. Tab. xxvi. fig. 8. (22?)

Suborbicular, much depressed, concentrically laminated, ears nearly equal.

This shell so closely resembles P. *orbicularis* of Sowerby, (*Min. Conch.* tab. 186.) that at first I was induced to consider it as belonging to that species; a more careful examination has however detected differences which appear to be specific.

The striæ in P. *orbicularis*, are described as elevated and sharp; but in the shell before us they are very slight, and are produced by the termination of concentric laminæ. The shell is very thin, and possesses a glossy appearance; the width and length are nearly equal.

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* Vide Chalk Fossils, No. 64.

Tab. xxvi. fig. 8, a fine specimen, with the shell entire.

——— fig. 22, is probably the under valve of this species.

Localities. Hamsey, Stoneham.

55. Pecten ——— Tab. xxvi. fig. 7.

Although the valve here figured is perfect, yet as it only exhibits the inner surface, and resembles in form several other shells of the genus, the species cannot at present be ascertained.

Locality. Hamsey.

56. Plagiostoma? *aspera*. Tab. xxvi. fig. 18.

Subdepressed, obovate, with numerous longitudinal, aculeated sulci.

To the naked eye, this shell appears as if marked with smooth, longitudinal striæ, but conveys a sensation of roughness to the touch. With the assistance of a lens, the striæ are perceived to be sulci, dividing the surface into flat ribs, the edges of which are fringed with minute sharp points. It has a few irregular lines of growth: the structure of the hinge is not shewn in any of the specimens in my possession.

This shell bears considerable resemblance to *Lima spathula* of Lamarck.

Localities. Hamsey, Stoneham: rare.

57. Plagiostoma ———. Tab. xix. fig. 1.

The cast of a transversely ovate, depressed bivalve, apparently of this genus. It has fifteen prominent costæ, which diverge from the beaks to the margin; the latter is undulated.

Localities. Hamsey, Middleham.

58. Plicatula *spinosa*. Tab. xxvi. figs. 13. 16, 17.

"Ovate, depressed, spinous; spines adpressed, smallest on the deeper valve, margin entire*."

The specific description is that given by Mr. Sowerby; the Sussex specimens being imperfect, and differing in some particulars from those figured in the *Min. Conchology*. The latter are described as being

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* *Min. Conch.* Vol. iii. p. 79.

"obliquely ovate, with an angle at the beaks, the deeper valve having radiating undulations, with numerous minute aculei; these are sometimes wanting. The other valve is for the most part externally concave, without undulations, but bearing sharp hollow spines with their points pressed close to the surface, and often hooked. The surface that received the semi-external cartilage, is sometimes very distinct, extending transversely upon the beaks, so as almost to form ears *."

Tab. xxvi. figs. 13. 17, agree in many respects with the above description: the shell is very thin, and the spines closely pressed to the surface.

——— fig. 16, is more convex than the preceding, has but few spines, and possesses a lamellated structure. Some specimens of this kind are nearly orbicular, almost destitute of spines, and frequently exceed 1·5 inch in width and length; these probably belong to another species.

Localities. Hamsey, Stoneham; mutilated specimens are very common.

59. Terebratula *subrotunda*. *Min. Conch.* Tab. xv. figs. 1, 2.

Subrotund, somewhat depressed, smooth, valves equally convex, beaks short.

This and the following species are abundant in the chalk †, but of rare occurrence in the marl; they are so common, that a particular description is unnecessary.

Localities. Hamsey, Eastbourne.

60. Terebratula *subundata*. *Min. Conch.* Tab. xv. fig. 7.

Subovate, somewhat depressed, smooth; valves equally gibbous, margin depressed in front, with two lateral undulations.

Localities. Hamsey, Eastbourne.

61. Terebratula *sulcata*.

Depressed, transversely ovate, with diverging longitudinal furrows; upper valve convex, lower valve depressed anteriorly; front of the depressions straight, plicated, with an undulation on each side; beak small, margin serrated.

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* *Min. Conch.* Vol. iii. page 80.

† Vide Chalk Fossils, No. 76.

The shell is about 0·5 inch long, and 0·6 wide. The sulci are strongly marked, about fifteen or sixteen on each valve, three or four occupying the straight front of the margin. The beak is slightly produced, and has a circular perforation.

This species is common at Hamsey: the sulci are bolder and fewer in number on the straight part of the margin, than in the other Terebratulæ of the chalk.

Localities. Hamsey, Stoneham.

62. Terebratula *Martini*.

Subscrotiform, longitudinally striated, margin finely serrated; both valves slightly depressed in front, beaks very small.

This is a very minute and delicate species, scarcely 0·3 inch either in length or width. Each valve is marked with upwards of thirty longitudinal striæ, and both are equally convex. The margin is finely serrated by the terminations of the striæ, and is nearly straight in front; the sides are not waved, as in the last species.

The specific name is in commemoration of the late William Martin, Esq. F.L.S. of Macclesfield, the scientific author of Petrificata Derbiensia, &c. whose premature death must be deeply lamented by every friend of science.

Locality. Hamsey.

63. Terebratula *striatula*. Tab. xxv. figs. 7, 8. 12.

Subscrotiform, contracted at the beaks, longitudinally striated, striæ fine, diverging; margin acute, undulated in front, depressed on each side the beak; lower valve with a broad longitudinal sulcus.

The length of this species is generally 0·9 inch; the greatest width 0·7 inch; thickness 0·4 inch.

The upper valve is convex in the middle, and gradually slopes towards the margin; the lower valve has a sulcus along the middle. The beak is slightly produced, and beneath it the margin is inflected on both sides. The striæ are fine, diverging from the beak to the margin; the latter is acute, and has a gentle undulation in front, produced by the dorsal groove; in the young shell this appearance is not observable.

The specimens are marked with transverse lines of increase.

The form of this shell resembles that of CONCHYLIOLITHUS *Anomites sacculus* of Martin*, but that species is more convex, and is destitute of striæ.

Tab. xxv. figs. 7, 8. 12, exhibit a dorsal, front, and lateral view of the same specimen.

Locality. Hamsey: very rare.

64. Terebratula *squamosa*.

Longitudinally ovate, valves equally convex, surface squamous, margin of the lower valve incumbent, beaks produced.

Length 0·5 inch, width 0·4 inch; the greatest convexity of the united valves, 0·3 inch. Both valves are equally gibbous; the margin of the lowermost is slightly incumbent, and surrounds the edge of the upper valve. The lines of increase are numerous, concentric, and squamous. The beak is a little produced, and has a circular aperture.

The shells of the Terebratulæ of the grey marl, are always in a good state of preservation; in the present species even some vestige of the colour remains, the specimens being invariably of a bluish hue.

Locality. Hamsey.

65. Inoceramus *tenuis*.

Valves convex, marked with numerous fine concentric lines; posterior side depressed, small, lunulate? hinge side short, expanded; beaks convex, incurved; hinge oblique.

The shell of this species is remarkably thin and fragile, and is marked with numerous concentric lines produced by the lamellated structure of the surface. The valves are regularly convex, and deepest in the middle.

The posterior slope is small and lunulate; the anterior, short and expanded. The hinge is rather oblique.

A few indistinct transverse undulations are observable in some examples. The specimens are usually about four inches long, and three inches wide: the depth of the united valves 2·8 inches.

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* *Petrificata Derbiensia*, tab. 16. figs 1, 2.

Localities. Hamsey, Offham.

66. Inoceramus *Cripsii*. Tab. xxvii. fig. 11.

Obovate, much depressed, with numerous concentric transverse ridges; beaks acuminated; posterior side small, depressed; anterior side expanded; hinge oblique?

The valves are of an obovate form, much depressed, and marked with strong concentric ridges, somewhat obliquely disposed. These characters distinguish the present species from the one above described. The beaks are acuminated. The shell increases in width, but diminishes in depth as it approaches the front. The posterior slope is small and depressed; the anterior, expands to form the hinge furrow.

Casts of this species are common, but the shell is seldom preserved. I have named it in honor of my esteemed friend John Martin Cripps, Esq. M.A., and it is with great pleasure that I thus publicly express my grateful acknowledgments for his kind exertions, in promoting the success of the present publication.

Localities. Ringmer, Hamsey, Offham.

Several other species of Inoceramus occur in the grey marl, but the specimens hitherto discovered, are in too mutilated a state to admit of accurate determination.

Fossil Fishes.

The Grey Marl has afforded a few examples of the remains of fishes, but these are exceedingly imperfect: fragments of bones, a few small vertebræ, irregular patches of scales, and an inconsiderable number of teeth, are the only specimens hitherto noticed.

67. Remains of a fish. Tab. xxxiv. fig. 10.

This fossil was discovered at Hamsey; it shews vestiges of the tail, and of one fin, but no conjecture can be formed of the genus of the original.

68. Tooth of the Squalus *mustelus.*

A tooth, apparently of this species of shark, is delineated in Tab. xxxii. fig. 5. It is very rare.

Locality. Hamsey.

69. Tooth of the Squalus galeus. Tab. xxxii. fig. 12.

This specimen resembles the teeth of the recent species.

Locality. Hamsey, Eastbourne.

CRUSTACEA.

Of the remains of Crustacea, a few portions only have been found; sufficient indeed to prove the existence of this order of animals in the grey chalk marl, but too imperfect to allow of a detailed description.

XII.

§ II. 7. LOWER CHALK.

XIII.

§ II. 8. UPPER, OR FLINTY CHALK.

These deposits form by far the most considerable and important divisions of the chalk formation, and constitute the most striking features of the geology of Sussex. As their investigation is highly interesting, we shall endeavour to elucidate the subject, by subjoining a brief notice of the course of the chalk through the south-eastern part of England, and on the Continent.

We are informed by Mr. Townsend, "that the chalk hills are bounded by a line which stretches from south-west to north-east, and that within these limits they form three principal mountain ranges. The first, leaving Berks, runs north through Bucks, Bedfordshire, and Hertfordshire, into Cambridgeshire, by Dunstable, Hitching, Baldock, and Royston, to Gogmagog Hills, near Cambridge. The second, passing from Berkshire eastward, stretches through Surrey, where it forms the Hog's back, that beautiful ridge which extends from Farnham to Guildford, and then appears at Boxhill. This branch forms the hilly country and the downs north of Reigate, Bletchingley, and Godstone. It enters Kent to the north of Westerham, and extends by Riverhead, to Wrotham, south of Dartford, Rochester, Lenham, and Canterbury, to Folkestone and Dover. One division of this ridge is continued to the north coast of Kent, by Feversham, near Sheppey, Margate, and North Foreland to Ramsgate.

"The third range, leaving Wiltshire and Berkshire, enters Hants, and to the south passes round Petersfield, then, stretching to the east, forms a barrier against the sea along the coast from Chichester and the South Downs as far as Dover, and ranges from Maple-Durham, Houghton, Steyning, and Lewes, as far as Beachy Head[*]."

Insular parts occur in the Isle of Thanet, and Isle of Wight[†].

In France the chalk prevails on the skirt of the western boundary of Mount Jura, extending nearly in a direction from S.E. to N.W., and covering a space of at least 210 miles long, and 50 broad.

Chalk also occurs in Ireland, Saxony, Spain, Denmark, Sweden, and Poland[‡].

The thickness of the chalk formation varies considerably in different parts of its course. Near Royston it attains an elevation above the sea of 481 feet; south of Dunstable, it is 994 feet; south of Shaftsbury, 941 feet; between Lewes, in Sussex, and Alton, in Hampshire, various parts of the range rise to the height of between 800 and 900 feet; and between Alton and Dover, between 700 and 800 feet[§]. In the Sussex range Ditchling Beacon, which is the highest point, is 856 feet above the level of the sea.

The mountain ranges formed by the chalk, are characterized by their smooth and unbroken outline, and are generally covered with a short verdant turf[‖].

The earlier inhabitants of this island, either from choice or necessity, fixed their settlements on the elevated ridges and platforms of this formation; and vestiges of their sepulchral mounts are still visible scattered here and there, over the Downs. Stone-henge, and other druidical temples are situated upon it, being composed of immense blocks of the siliceous sandstone, that occurs in the form of boulders, on various parts of its surface.

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[*] *Townsend's Moses*, Vol. i. page 142.

[†] *Smith's Strata*. For a more particular account of the range and extent of the chalk formation, vide *Phillips' Geological Outlines*, edition 1822, page 77.

[‡] *Dr. Berger*, *Geological Transactions*, Vol. i. page 14.

[§] *Phillips' Outlines*, 2d edition, 1816.

[‖] "In Champagne, in France, there are immense plains of chalk absolutely destitute of vegetation, except where patches of the *Calcaire grossier* occur as islands, or oases in the midst of these deserts. Many parts of this tract have perhaps not been visited for ages by any living being, no motive existing that could induce any one to wander there. This chalk is said to contain 11 per cent. of magnesia, to which the barrenness of the soil is supposed to be owing." *Geological Transactions*, Vol. ii. p. 175.

The description of the South Downs inserted in a former part of this work, will sufficiently explain the range, and extent, of the Upper and Lower Chalk, in the south-eastern part of Sussex; varying in altitude from 300 to upwards of 800 feet, this chain of hills extends from Beachy Head along the coast to Brighton, from whence it stretches through the centre of western Sussex, into Hampshire. On the north it presents a precipitous escarpment to the Weald, but its southern side descends with a gentle slope, and on the south-west is lost beneath the beds of the Isle of Wight basin; while the south-eastern part forms a line of chalk cliffs of considerable extent.

The South Downs are intersected by four transverse vallies of considerable extent, through which the Arun, the Adur, the Ouse, and the Cuckmere, flow from the interior of the country into the British Channel; the course of these rivers has already been described.

The general dip or inclination of the strata of the Sussex range, is to the south-east; in a few instances, however, the influence of local causes has occasioned some exceptions.

The summits of the hills are generally covered with a layer of loose flints, which lies immediately beneath the turf; and in some places, beds of sand and clay, with boulders of siliceous sandstone, and breccia, and other accumulations of diluvial detritus, obtain a similar situation. In numerous places on the sides and at the base of the Downs, quarries have been opened, and kilns erected, for converting the chalk into lime, of which immense quantities are annually consumed by the Sussex agriculturists. These partial sections in the interior, together with the line of coast from Brighton to Beachy Head, afford ample opportunities for the examination of the geological structure of this interesting chain.

We now proceed to a more particular survey of the deposits included in the present section; but before entering on their investigation, it may be necessary to offer a few remarks, upon the substance of which they are principally composed.

Chalk[*] is a mineral too well known to require description, and yet its characters are such as could not fail to excite attention, if less frequently presented to our notice.

The Sussex chalk varies in colour from pure white to a bluish grey, and differs considerably in its coherence and composition. It has an earthy fracture, is meagre to the touch, and adheres to the tongue; it is dull, opaque, soft, and light, its specific gravity being about 2·3. It is composed of lime and carbonic acid, and contains an inconsiderable proportion of silex and iron.

The harder varieties of this substance were formerly in great request for building, and when protected from the influence of the atmosphere by a thin casing of limestone, or flint, proved very durable. The ruins of the priory of St. Pancras, near Lewes, which have stood nearly 800 years, afford a remarkable instance of this kind; the interior of many of the walls are six feet thick, and are entirely formed of chalk, the outside having a facing of Caen-stone and squared flints. At present, chalk is seldom used in architecture, except in the construction of vaults, cellars, and other subterranean works.

The Sussex chalk forms two principal divisions, viz.; the lower or hard chalk, which is destitute of flints; and the upper chalk, which contains numerous layers of siliceous nodules, and veins of flint[†].

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[*] Various conjectures have been offered respecting the probable origin of chalk, and the mode of its formation. Patrin[*] supposed that it was the production of three different causes.

1. Animal earth, proceeding from the decomposition of organic bodies.
2. Calcareous lava ejected by submarine volcanoes.
3. Detritus of calcareous mountains.

Delamètherie imagined it to have been deposited by water in a state of great agitation[†].

In Ireland, the chalk acquires a degree of hardness equal to that of compact limestone. In its geological position, and in the nature of its fossils, it corresponds, however, with that of England, with which it is considered to be entirely identified. In many places it is covered by basalt. It contains *echinites*, *terebratulæ*, *ammonites*, and *belemnites*.—*Geological Transactions*, Vol. iii. pp. 169. 129.

[†] In some parts of England the beds of chalk admit of a more minute division. Those

[*] *Dict. d'Histoire Naturelle*, Tom. vi. p. 472.

[†] *Journal de Physique*, Tom. lxxx. p. 37.

XII.

§ II. 7. LOWER CHALK.

THE absence of siliceous nodules, and the superior hardness of the chalk, distinguishes this deposit from that which lies above it.

Its colour is of a light grey, enclosing masses of pure white. It forms the low elevations at the foot of the Downs, and as the situations it occupies are generally easy of access, a considerable number of quarries have been opened in different parts of its course. It is regularly stratified, the lines of separation being composed of a softer chalk, that in some places contains so great a proportion of argilla, as to assume the appearance of marl. The latter also occurs in transverse and vertical veins, in which the remains of fishes are more frequent than in the more solid strata.

The general inclination of the beds is towards the south-east, at an angle of from 5° to 15°. Their total thickness has not been determined, but is probably not less than 200 feet. A well sunk on the side of the hill, near Glyndbourne, passed through 120 feet of the lower chalk only. The lowermost beds were of a deeper grey than the upper, but presented no other material variation. The cliffs that extend from near Beachy

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in the vicinity of Dover, described by Mr. Phillips (*Geological Transactions*, Vol. v. p. 18.), are separated by that gentleman into the following, viz.

1. Chalk with numerous flints, 350 feet thick; which is subdivided into
    1. A bed with few organic remains.
    2. Chalk with interspersed flints, consisting chiefly of organic remains, in which numerous flints of peculiar forms are interspersed, and a few beds of flint.
2. Chalk with a few flints; this stratum is about 130 feet thick.
3. Chalk without flints, 140 feet thick, consisting of
    1. A stratum containing very numerous and thin beds of organic remains, 90 feet thick.
    2. A bed 50 feet thick, with few organic remains.
4. Grey chalk, estimated at 200 feet in thickness.

Head to Southbourne, expose this bed at their base, and afford considerable facility for its investigation.

Near Lewes, the lower chalk occurs in the quarries at the foot of Malling Hill, Southerham, Glynd, Glyndbourne, Swanborough, Plumpton, &c.; and in other parts of the county, along the northern edge of the Downs, reposing immediately on the grey chalk marl.

The quarry at Southerham, (vide Tab. ii. fig. 3. and Tab. vii.) is remarkable for the inclination and direction of its beds; it is situated on the east side of the road, on the south-western extremity of Cliff Hills. It is about 30 feet high, and contains from eight to ten layers of chalk, the latter varying in thickness from one to eight feet, being separated from each other by intervening seams of friable chalk marl. These exhibit decided proofs of having suffered considerable displacement; they are inclined obliquely towards the north, at an angle of from 20° to 30°, their planes being depressed towards the west. Northward from this spot, at the distance of about 300 yards, the upper chalk is exposed in the pit of Messrs. Hillman, in South Street, and here the strata are horizontal. The hill in which both these quarries occur, presents a smooth unbroken outline, conveying no indication of the changes that have taken place beneath its surface; hence we may infer, that the displacement of the strata was antecedent to those revolutions, of which the present form of the country affords such unequivocal evidence.

MINERALS.

1. Sulphuret of iron is the only metallic substance that occurs in the lower chalk; and of this mineral some elegant crystals, of a reddish or yellowish brown colour, have been discovered, in the quarries at the foot of Malling Hill.

Tab. xvi. fig. 11, represents the usual form of the specimens. It consists of nine or ten quadrangular columns, formed of octohedrons piled upon each other; these proceed from one common centre, and each terminates in a quadrangular pyramid*.

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* Similar specimens have been discovered by Mr. Wm. Phillips, in the lower chalk at Dover. Vide *Geological Transactions*, Vol. v. p. 37.

The lower chalk, near Beachy Head, contains small cylindrical masses of pyrites of a steel grey colour, that possess a very brilliant lustre; their surface is generally invested with pyramidal crystals, having their solid angles replaced by quadrangular planes.

2. Green sandstone. Small portions of this substance, evidently of the same nature as the chlorite sand, have been discovered in the chalk at Southerham.

ORGANIC REMAINS.

These correspond in most instances with the fossils of the upper division; but as they are comparatively of rare occurrence, it will be more convenient to include them in the general description of the organic remains of the chalk. We shall therefore confine ourselves, in this place, to an enumeration of those which occur in the lower chalk of Sussex.

1. Wood; very rare.
2. Supposed juli of the larch.
3. Ventriculites *radiatus*. The remains of this zoophyte are very rare in the lower chalk, and generally consist of the stirps only.
4. Ventriculites *alcyonoides*: rare.
5. Choanites *subrotundus*.
6. Apiocrinites *ellipticus*.
7. Conulus *albogalerus*.
8. Cirrus *depressus*.
9. —— *perspectivus*.
10.* —— *granulatus*.
11. Ammonites *varians*: very rare.
12.* ———— *Woollgari*.
13.* ———— *catinus*.
14.* ———— *rusticus*.
15.* ———— *Lewesiensis*.
16.* Belemnite.
17. Plagiostoma *Brogniarti*.

18. Ostrea.
19. Terebratula *subrotunda*.
20. ———— *ovata*.
21. ———— *undata*.
22. Inoceramus *mytilloides*.
23.* ———— *Websteri*.
24.* ———— *striatus*.
25. ———— *latus*.
26. Astacus *Leachii*.
27. Squalus *cornubicus* (the teeth of).
28. ——— *mustelus*.
29. ——— *zygæna*.
30. Balistes (fins or radii of).
31. Diodon (molar teeth of).
32. Zeus *Lewesiensis*.
33. Muræna *Lewesiensis*.
34.* Salmo *Lewesiensis*.
35.* Amia? *Lewesiensis*.

*Those marked thus * have not been discovered in any other deposit.*

XIII.

§ II. 8. UPPER, OR FLINTY CHALK.

The Upper Chalk is characterized by its numerous parallel layers of flint. In this county it constitutes by far the most considerable portion of the chalk formation, extending to the summits of the highest hills, and in some instances reaching nearly to their base.

The chalk of this deposit is generally of a purer white, and of a softer texture, than the inferior strata; but in other respects, presents no sensible difference. It is regularly stratified, and partakes of the general inclination of the other divisions of the series. It is separated by horizontal layers of siliceous nodules into beds that vary from a few inches, to several feet in thickness, and which, in some localities, are traversed by obliquely vertical veins of tabular flint, that may be traced for many yards without interruption. These are sometimes disposed horizontally, and form a continuous layer of thin flint, of very considerable extent.

The nodular masses of flint are very irregular in form, and variable in magnitude; some of them scarcely exceeding the size of a bullet, while others are several feet in circumference. Although thickly distributed in horizontal beds or layers, they are never in contact with each other, but every nodule is completely surrounded by the chalk. Their external surface is composed of a white opaque crust, consisting of an intermixture of chalk and silex, probably formed by a combination of the outer surface of the nodule with its investing matrix, while the former was in a soft state. Internally they are of various shades of grey, inclining to black, and often contain cavities lined with chalcedony and crystallized quartz.

When first extracted from the quarry, flint is brittle, has a conchoidal fracture, and feeble lustre; thin fragments are translucent. Its specific gravity is 2·594. According to the analysis of Klaproth, it consists of

Silex -	98·	Oxide of iron - -	0·25
Lime -	0·5	Water - - -	1·
Alumine -	0·25		

It is infusible, but upon being submitted to a great heat becomes white, and opaque. By exposure to the atmosphere, it undergoes considerable change, and assumes a yellow or ferruginous colour, an appearance commonly exhibited by the flints of our ploughed lands. When in contact with ochraceous clay, or sand containing iron, it frequently attains a dark carnelian colour externally, the interior being of a lighter shade; of this kind, numerous beds occur in the parish of Barcombe.

Flints so commonly enclose the remains of sponges, alcyonia, and other zoophytes, that some geologists are of opinion that the nucleus of every nodule, was originally an organic body *. That this has been the case in most instances is very evident; and in Sussex, there are comparatively but few flints, that do not possess traces of zoophytical organization. These nodules oftentimes exhibit not only the outline of the original zoophyte, but also its internal structure, preserved in the most delicate and beautiful manner that can be conceived. In some examples the zoophyte has undergone decomposition, and the space it occupied been partially filled with an infiltration of agate, chalcedony, and crystallized quartz.

Although even in the present advanced state of chemical science, we are unacquainted with the process by which silex may be dissolved in water, yet that its solution was formerly effected by natural causes on a very extensive scale, the siliceous nodules, whose history is the subject of these remarks, afford the most conclusive evidence. At the present moment, nature in her secret laboratories is still carrying on a modification of the same operations; of which we have remarkable instances in the boiling springs of the Geyser, in Iceland †, and of Carlsbad, in Bohemia ‡. Nor

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* "So far as my observation extends, zoophytes appear universally to have formed the nuclei of nodulated and coated flints." *Townsend's Character of Moses.*

† The depositions of siliceous tufa, or chalcedony, formed by the boiling springs of the Geyser, in Iceland, are well known; these waters contain 31·38, of silex per gallon. Vide *Travels in Iceland*, by Sir George Stewart Mackenzie, Bart. 4to. Edinburgh, p. 389.

‡ According to the experiments of Klaproth, the spring at Carlsbad contains 25 grains of silex in 1000 cubic inches of water.

is a high temperature absolutely essential to the solution of silex in water, since this earth occurs in a large proportion in the mineral waters of our own island *, and also enters into the composition of the epidermis of various plants of the cane tribe, and of the English reeds, and grasses. The epidermis of the Equisetum hyemale, or Dutch rush, consists almost entirely of silex †.

There is scarcely a single fact in geological science, that has so much excited the attention of philosophers, or given rise to so many unsatisfactory conjectures, as the formation of the siliceous nodules of the chalk. Upon this interesting subject, which is still involved in much obscurity, I shall not presume to hazard an opinion, but content myself with offering a condensed view of those theories, that have received the sanction of some of our most eminent geologists.

The celebrated Werner, whose opinions are embraced by Professor Jameson, Mr. Parkinson, and others, offers the following explanation of the phenomenon in question. He supposes, that "during the deposition of the chalk, air was evolved, which, in endeavouring to escape, formed irregular cavities that were afterwards filled up by infiltration with flint. The decomposition of the softer parts of the animals thus entombed, may be considered as a probable source of part of the gaseous matter that formed these cavities; and the connexion of the animal remains with those nodules of flint, is easily explained by supposing the shells, crusts of echini, &c. to have projected into the hollows, or to have been adherent to their sides, at the period at which this infiltration took place. That the separation and disposition of the matter forming the nodules, have been the effect of crystallization, is rendered evident by the cavities left either in these nodules, or in the fossils, being generally lined with quartz crystals ‡."

Upon this subject Dr. Berger § remarks, that with regard "to the formation of flints in chalk, if we adopt the theory of Werner, I should be as

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* The mineral waters of Bath contain twenty grains of silex in ten pints and a half. *Nicholson's Journal*, Vol. iii. p. 403.

† *Organic Remains*, Vol. i. p. 328.

‡ *Geological Transactions*, Vol. i. p. 350.

§ *Ibid.* p. 96.

much disposed to attribute the void spaces in the chalk to a natural contraction of its substance, as to the disengagement of air. We know that chalk divides, by drying, into compartments that are sometimes very regular, nearly in the same way as marl. According to this hypothesis, we may suppose either that the chalk and the flints are of contemporaneous formation, that the elements of flint were mixed with those of the chalk, and that they separated from each other by elective affinity, or that the siliceous matter has been afterwards introduced, and has filled up the cavities left in the chalk."

Professor Buckland, whose opinions on geological subjects merit the highest consideration, objects altogether to the explanation offered by the Wernerian theory. "It does not," he remarks, "appear possible that the flints could have been formed by infiltration into pre-existing cavities, like the regularly disseminated geodes of the trap rocks; since this hypothesis, in the case of chalk, would imply the anomaly of their having once existed uniformly over many hundred square miles, as many strata of air bubbles as there are of flint, alternating with the chalk; and of which air-holes not one was left empty, or partially filled; whilst, on the other hand, many of the nodules could not have been formed in such air-holes, as they entirely derive their shape from some extraneous bodies affording a nucleus to the silex that has incrusted them*." He then offers the following ingenious theory, as the result of a diligent investigation of the subject. "Assuming that the mass which is now separated into beds of chalk and flint, was, previously to its consolidation, a compound pulpy fluid, and that the organic bodies now enveloped in the strata were lodged in the matter of the rock, before the separation of its calcareous from its siliceous ingredients, he conceives that the bodies thus dispersed throughout the mass, would afford nuclei, to which the flint, in separating from the chalk, would, upon the principle of chemical affinity, have a tendency to attach itself. The chalk and flint he considers to have proceeded through a contemporaneous process of consolidation, the separation of the siliceous from the calcareous ingredients, having been modified by attractions, which drew to certain centres the particles of the siliceous nodules, as they were in the act of separation from the original compound mass. The distances of the siliceous strata he imagines to have been regulated by the intervals of precipitation, of the matter from which they are derived; each new mass, as it was discharged, forming a bed of pulpy fluid at the bottom of the then existing ocean, which being more recent than the bed produced by the last preceding precipitate, would rest upon it as a foundation similar in substance to itself, but of which the consolidation was sufficiently advanced, to prevent the ingredients of the last deposit, from penetrating or disturbing the productions of that which preceded it [*]."

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* *Geological Transactions*, Vol. iv. p. 422.

That the beds of chalk and flint were deposited periodically, cannot admit of the slightest doubt. Specimens are not unusual, in which angular fragments of black flint, that could not possibly have been originally formed in their present state, are imbedded in chalk. An example of this kind in my possession, contains several portions of flint which are as sharp and translucent as if recently broken, and entirely destitute of the external opaque crust invariably seen in the perfect nodules; these are imbedded in, and separated from each other by the chalk. It is sufficiently obvious that the nodule from which these pieces were derived, must have been displaced and broken, subsequently to its original formation, and the fragments afterwards enveloped in another and more recent stratum of chalk [†].

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[*] Vide *Geological Transactions*, Vol. iv. p. 420.

[†] As connected with the history of the formation of siliceous nodules, I cannot refrain from noticing in this place, the extraordinary circumstance of coins, and other antiquities, having been found enclosed in them.

In *Schneider's Topog. Mineral.* mention is made of 126 silver coins, that were found enclosed in flints at Grinoc, in Denmark [*]. It is however much to be regretted, that no description is given of the coins, nor any conjecture offered of their probable age; since, if the account be correct, the determination of that circumstance would fix a certain date to one era, at least, of the formation of flint.

Mr. Knight Spencer, in a letter published in *Bakewell's Introduction to Geology* [†], relates the following interesting story, and which, from its authenticity, may be considered as decisive of the comparatively recent formation of flint, in certain situations.

"In 1791, two hundred yards north of the ramparts of Hamburgh, in a sandy soil, M. Liesky of that city picked up a flint, and knocking it against another, broke it in two. In the centre of the fracture he observed an ancient brass pin, and on picking up the other half, he found

[*] *Phillips' Mineralogy*, 2d edition, p. 12.

[†] *Bakewell's Introduction to Geology*, 8vo. 1813, p. 338.

But to return from this digression.—The line of coast from Brighton to Beachy Head, exposes an interesting vertical section of the upper chalk, exhibiting almost every variety of character hitherto remarked in the beds of that deposit.

At Brighton, the cliffs are composed of an accumulation of diluvial substances, resting upon the solid chalk, which there constitutes the sea-shore, and continues to Rottingdean. From thence to Newhaven, the cliffs are nearly perpendicular, and on the western side of the harbour rise into an irregular elevation called Castle hill, the upper part of which, is composed of numerous beds of the plastic clay formation: the lowermost fifty feet consisting of the flinty chalk. On the opposite side of the river, a low mound of chalk, capped with a bed of plastic clay and ferruginous breccia, appears at Chimting Castle. Proceeding eastward towards the Signal-house, near Seaford, the chalk rises to a considerable height, and forms a majestic line of cliffs from thence, to the embouchure of Cuckmere river; from this place they extend eastward, and terminate in the magnificent promontory of Beachy Head, which is nearly six hundred feet above the level of the sea *. Along this line of coast, Ammonites of a large size, Plagiostomæ, Terebratulæ, Echinites, and other productions of the chalk, may be obtained in considerable numbers.

The sections in the interior of the country are entirely artificial; of these, the following are the most interesting, that occur in the south-eastern part of the county.

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the corresponding mould of the pin so laid bare; he presented them to Thomas Blacker, Esq. in whose possession they now are, and who has shewn them to the writer of this paper."

In the *Gentleman's Magazine* for 17—, mention is made of an ancient brass key (a figure of which is there engraved) having been found in a block of chalk at Guilford, in Surrey. My friend, J. B. Durrant, Esq. of Malling-house, had the kindness, in compliance with my request, to inquire into the correctness of the account, but it proved, as indeed might have been expected, too apochryphal to be worthy of credit.

* The following circumstance is too singular to be omitted. One of those prodigious falls of the chalk cliffs, which make a residence near them frequently so dangerous, occurred at Beachy Head a few years since. The clergyman of East Dean was walking on the brink of the precipice, when he perceived the ground to be sinking from under him, and although he had the presence of mind instantly to rush from the impending danger, a deep chasm had formed at some distance from the edge of the cliff, over which he had escaped but a few moments, before the mass of chalk upon which he had been standing, to the extent of three hundred feet in length, and eighty in breadth, fell with a tremendous crash into the sea. *Geological Transactions*, Vol. ii. p. 191.

Holywell quarry, near Eastbourne; contains Echinites, Plagiostomæ, Inocerami, Terebratulæ, the remains of Fishes, &c.

Alfriston chalk-pit; remarkable for crystallized carbonate of lime of considerable purity.

Cliff Hills. The pits formed on the sides of this insulated portion of the chalk hills, produce a great variety of fossil shells, and zoophytes, the remains of fishes, and the vertebræ and bones of unknown animals. In some of these quarries, after a recent fall, the chalk presents a remarkable appearance; the newly exposed surface is of a brown colour, and uniformly marked with fine vertical striæ, giving to the mass a fibrous appearance. Small conical portions of the chalk sometimes partake of the same character, and I have specimens that closely resemble calcareous fossil wood. In every instance, however, this structure is confined to the surface, and does not affect the interior of the chalk. In all probability it has been produced by a subsidence of the strata, which caused them to slip over each other, before they were entirely consolidated *.

South-street pit, near Lewes, affords a fine section of the flinty chalk, exceeding two hundred feet in height. An irregular canal or dyke, varying from two to eight feet in diameter, traverses this quarry, in an oblique direction. It was noticed many years since at the northern extremity of the pit, and subsequent falls of chalk have from time to time exposed its course towards the centre, from whence it now appears to proceed easterly: a section of it is still perceptible at an elevation of a few feet. In some parts this cavity was almost empty, and in others nearly filled by sand, clay, and ochre of a light chocolate colour. This canal or dyke has probably been formed by a subterranean current of water, the substances it contains being evidently alluvial. South-street pit is also remarkable, as being the only known locality of the detached octaëdral sulphuret of iron. It contains the scales, teeth, &c. of fishes, and numerous shells and corals.

Beddingham pit is situated on the side of the Downs, about a mile distant from the village. In ascending the hill, the grey marl, lower

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* An appearance somewhat similar occurs in the limestone beds of Derbyshire, and is there termed "*slickensides.*"

chalk, and flinty chalk, are passed over in succession. The pit is between twenty and thirty feet high, and consists of,

1. Vegetable mould intermixed with chalk rubble,	1 foot.
2. Chalk rubble, - - - - - - -	3 feet.
3. Flinty chalk, - - - - - - -	20 feet.

The chalk is stratified in horizontal beds from two to four feet thick, and these are separated in some instances by layers of flints, and in others by chalk rubble; flints are also irregularly disposed throughout the mass. This spot is peculiarly interesting, from the circumstance of the strata having been rent asunder since their original deposition. Vertical fissures are every where observable, and these are partially filled with broken chalk and flint, cemented together by crystallized carbonate of lime, of a light amber colour. The sides of the fissures are incrusted with the same substance, which has insinuated itself into the crevices of the surrounding chalk, and also occurs in irregular concretions in the cavities of the flints. The surface of these stalactitical depositions of calcareous spar, is frequently covered with delicate undulations, as if the water had been suddenly congealed, while in a state of agitation.

Piddinghoe. This pit lies on the road side, near the village of the same name; it is remarkable for the purity and softness of the chalk, and for the numerous vertical and oblique veins of tabular flint, by which it is traversed. These veins are of a most extraordinary character; for although the flint retains its original form and situation, yet upon examination, it is found to be cracked and shivered in every direction. The fractured flint falls to pieces upon being removed from the chalk, but in some instances it is held together by sulphuret of iron, forming a conglomerate of silex and pyrites, of a very singular appearance. The phenomenon here remarked, is not however confined to this quarry, but may be observed in several chalk-pits near Lewes and Brighton.

Sir Henry Englefield was the first who directed the attention of geologists to this subject. In a paper read before the Linnean Society, he notices several beds of shattered flints, which occur in a chalk-pit at Carisbrook, in the Isle of Wight; and after describing their appearance and situation, proceeds to offer some conjectures upon the probable cause of their destruction. This he supposed might have been occasioned by some sudden shock or convulsion, "which in an instant shivered the flints, though their resistance stopped the incipient motion; for the flints though crushed are not displaced, which must have been the case, had the beds slid sensibly *."

Offham pit, is nearly two hundred feet high, and exhibits a good section of the Sussex chalk. It contains the large fibrous bivalve, the fragments of which are so frequently met with in every locality; teeth and palates of fishes, and numerous zoophytes. It is the only locality near Lewes, in which the *Marsupites* have been discovered. South of this place, in a bank on the road-side, the chalk is covered by a bed of ochraceous clay, and where in contact with the latter, the chalk and flints are marked with regular stripes of yellow, bluish grey, and brown. This singular appearance extends into the substance of the chalk, but does not penetrate beyond the external crust of the flints: similar specimens sometimes occur in the pit in South-street.

Clayton pit. This locality produces Inocerami, Nautili, Plagiostomæ, Terebratulæ, Marsupites, &c.

Falmer. An excavation made on the side of the road, leading from the village, towards the farm of Mr. Moon, is particularly interesting from the evident proofs it exhibits of the changes the strata have suffered, since their original deposition. The pit is about twenty feet high, and contains the following beds; beginning with the lowermost.

1. Chalk with horizontal layers of large flints, -	6 feet.
2. Chalk much broken, containing interspersed flints,	10 feet.
3. Ochraceous clay and flint pebbles	from 2 to 4 feet.

From the upper part of the pit, several fissures of an irregular shape, and from three to six feet in diameter, extend through the broken chalk to the more solid beds beneath. Some of these cavities are of an inversely conical form, and others are nearly cylindrical. They are filled with ochraceous clay, rolled flints, and rounded masses of a conglomerate, consisting of pebbles and fragments of chalk, held together by a ferruginous cement. A portion of the pit in which sections of three of these wells occur, is represented Tab. iv. fig. 3. An appearance somewhat analogous is observable on the north side of the chalk-hill on which the church of St. John, *sub Castro*, in Lewes, is situate[*]. The broken chalk in Falmer pit is in very small pieces, the angles of which are perfect; a proof that although minutely divided, it has not suffered by attrition. The sides of the vallies of the South Downs, are universally composed of chalk, of a character precisely similar; an appearance, which in all probability, has resulted from the ruin of the chalk cliffs having accumulated in sloping taluses at their base.

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* *Linnean Transactions*, Vol. vi. p. 108.

Brighton pits. There are several chalk-quarries in the vicinity of this celebrated watering-place, but of these, one only is particularly worthy of notice[†]. The pit alluded to is situated near the church, and affords an excellent example of that fractured state of the chalk, which has been previously mentioned. It is thus described by Sir H. Englefield: "The upper part of this chalk is in separate masses, not perfectly rubble, but with all their tender angles sharp, exactly as if just broken to pieces to put into the lime-kiln, and quite clean, nearly of a size, and almost without any chalk powder mixed with them." Some remarkable veins of shattered flints occur in this quarry[‡].

Preston The quarry is extensive, and lies immediately behind the village; it formerly produced numerous remains of fishes, palates, teeth, &c. but is now seldom worked. It is however deserving of attention, on account of several thin veins of pure flint that fill up vertical fissures in the chalk, and which, to use the language of Sir H. Englefield, "appear exactly as if the flint, not being quite hard when the fissures took place,

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[*] A circumstance somewhat similar is mentioned by M. M. Cuvier et Brongniart. These naturalists remark, that in the beds of the lower marine formation, and particularly in those of Liancourt, natural wells of considerable size are sometimes found, filled with ferruginous and sandy clay, and waterworn siliceous pebbles. *Geolog. Trans.* Vol. ii. p. 208.

[†] This chalk is very pure; a specimen of the specific gravity 2·34, analyzed by my brother, was composed of,

Carbonic acid	43·4
Lime - -	56·0
Silica - -	0·6

[‡] *Linnean Transactions*, Vol. vi. p. 108.

had been squeezed out of the beds, and had run into the fissures as soft pitch would do: I do not mean that this was the case, but merely to describe the appearance *."

Steyning chalk-pits. These produce belemnites, plagiostomæ, dianchoræ, teeth, palates, &c. The sulphuret of iron found in these quarries is of a very singular form, being cylindrical, with a small projection at both extremities; a specimen is represented in tab. xvi. fig. 16.

MINERALS.

The minerals of the upper chalk are but few in number, and like the lower chalk, it contains but one metalliferous ore.

1. Crystallized quartz: this is of frequent occurrence in the cavities of siliceous nodules, shells, &c. The form of the crystals is that of a six-sided pyramid, their colours varying from a reddish brown to a light blue, amber, grey, and white.

2. Chalcedony, is often found occupying the hollows of flints, and is either mammillated, botryoidal, or stalactitical. It sometimes forms the constituent substance of corallines, alcyonites, and other zoophytes, displaying in the most delicate manner the complicated structure of the originals. Its colour is of various shades of grey, azure, and pearl white, and in many examples it is beautifully translucent: specimens are not uncommon, in which the surface of the mammillated chalcedony has received an investment of crystallized quartz.

The stalactitical and botryoidal varieties, are confined to those nodules which retain a part of the original zoophyte. In some instances the flint passes insensibly into chalcedony; in others the line of separation is most distinctly marked; but in all, there is sufficient evidence that the chalcedony and quartz were deposited by infiltration, and must have passed through the substance of the flint.

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* *Linnean Transactions*, Vol. vi. page 108.

On this subject Professor Buckland remarks, that "although, in the present compact state of the matter of flint, it is not easy, though possible, to force a fluid slowly through its pores, yet it is probable that before its consolidation was complete, it was permeable to a fluid whose particles were finer than its own; and that the particles of chalcedony, whilst yet in a fluid state, being finer than those of common flint, did thus pass through the outer crust to the inner station they now occupy; where they also allowed a passage through their own interstices to the still purer siliceous matter, which is often crystallized in the form of quartz in the centre of the chalcedony, and so entirely surrounded by it, that it could have no access to its present place, except through the substance of the chalcedony, and the flint enclosing it *."

3. Calcareous spar. This mineral is abundant in the fissures and hollows of the chalk, and forms the constituent substance of the shells and echinites. It is of various shades of amber colour, brown, and pearl white; the variety into which the shells and echinites are converted, is opaque, and has an oblique fracture. The other modifications generally possess some degree of transparency; in some of the larger bivalves, of the genus Inoceramus, the structure is fibrous.

The crystals of carbonate of lime are of various forms; the most usual are the rhomboidal, columnar, and acicular. The first occurs abundantly in cavities in the chalk,' immediately beneath the turf, on Plumpton Plain; and it is worthy of notice, that the hollows it occupies, have manifestly been formed subsequently to the consolidation of the chalk. In Western Sussex, branched cavities in the chalk, apparently occasioned by the decay of ramose zoophytes, are incrusted by this variety of calcareous spar†.

Of the columnar crystals, some fine specimens were brought to view by the tremendous fall of the cliffs near Beachy Head, that happened a few years since. These occurred in large masses of a yellowish colour, and the crystals when detached were semitransparent; Plumpton Plain,

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* *Geological Transactions*, Vol. iv. p. 419.

† From the correspondence of J. Hawkins, Esq.

Alfriston chalk-pit, and some other localities, have produced similar examples.

Obtuse rhomboidal crystals, of great beauty, have been found in a chalk-pit near Alfriston; their colour is of a delicate pearl white, and in their general appearance they resemble the double refracting spar of Iceland, except in their inferior degree of transparency. The cavities of echinites are sometimes lined with rhomboidal crystals of carbonate of lime, disposed in lines parallel with the sections formed by the areæ of the shell; and the inner surfaces of the terebratulæ, are frequently frosted over with drusy crystals of the same substance.

4. Sulphuret of iron, or iron pyrites, in subglobular and irregular masses, is very common in the upper chalk. The external surface of the specimens is invested by crystals of a pyramidal, octaëdral, or cubo-octaëdral form; and their interior exhibits a radiated structure, possessing a brilliant metallic lustre. When broken and exposed to the action of air and moisture, they undergo decomposition with great rapidity; and even in cabinets, frequently form an efflorescent sulphate of iron, and crumble into dust. This mineral occasionally incloses flints, shells, echinites, &c.* and frequently fills up the cavities of the latter. A specimen in my possession, exhibits on the upper side, a sharp cast of the interior of an echino-spatagus; and its base is covered with an elegant group of quadrangular pyramids, evidently the terminations of octaëdrons, with their inferior angles concealed.

The lower beds of the flinty chalk in South-street, contain detached crystals of sulphuret of iron, remarkable for their neatness and elegant figure. They are usually regular octaëdrons, having their planes studded with small quadrangular pyramids; but some examples occur in which the solid angles are replaced by quadrangular planes, forming a crystal with fourteen sides. A specimen of the former variety is represented, tab. xvi. fig. 10.

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* A terebratula imbedded in the centre of a nodule of sulphuret of iron, is represented in *British Mineralogy*, tab. 171. It was found in chalk by Mr. Weekes, of Hurstperpoint. This gentleman has also a perfect pyritous cast of Pecten *Beaveri*, from Clayton Hill.

ORGANIC REMAINS OF THE UPPER, AND LOWER CHALK.

The organic remains of the chalk are very numerous; but notwithstanding the important additions which modern discoveries have made, the fossil productions of this important deposit are still but imperfectly known.

The fossils of the French chalk have been described by M. M. Cuvier, and Brongniart *, and those of the English, by Mr. Parkinson †, W. Phillips, and others.

The contents of the Sussex beds, will be found to differ in many respects from those previously noticed, while many species of fossils, described by the authors above-mentioned, are unknown in this district. In their mode of preservation, however, a perfect correspondence exists in the productions of different localities They are for the most part remarkably entire, the delicate coverings of the crustacea, the spines of the shells, &c. remaining unbroken; in short, their appearance, as Mr. Parkinson justly remarks, "warrants the conclusion, that they have been enveloped and surrounded by the chalk, while living in their native beds; and that this deposition was effected at the bottom of a tranquil sea."

In every instance the shells, echinites, madreporites, and encrinites, are converted into calcareous spar, their cavities being filled with chalk, flint, or sulphuret of iron.

The remains of the softer zoopyhtes occur in the form of chalky casts, tinged with a yellowish or reddish oxide of iron; this appearance, which facilitates the separation of the fossils from the chalk, results from the decomposition of pyrites. The vertebræ and bones are soft and friable; but the teeth and palates are finely preserved, and have the natural polish of the enamel, heightened by an impregnation with iron. The scales and fins of fishes, and the coverings of the crustacea, are changed into a brown substance, which is exceedingly brittle, and fades upon exposure to the air.

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* *Essai sur la Geographie Minéralogique des Environs de Paris.* Par M. M. G. Cuvier, et Alex. Brongniart, p. 11.

† *Geological Transactions,* Vol. i. p. 344.

VEGETABLES.

1. Wood. This occurs in the same state as that of the chalk marl, but is in larger masses, and the ligneous structure more distinctly exhibited. It varies from a reddish brown, to a deep chocolate colour; and the more compact specimens possess the appearance and texture of charcoal [*]. In some instances the knots or rudiments of branches are perceptible; in others, perforations caused by the depredations of the teredo; and in one example the tubular part of the shell still remains. Wood is sometimes found in the centre of flints.

Localities. South-street; Offham.

2. Leaves. Tab. ix. figs. 1, 2, 12.

Impressions of a lineari-lanceolate form, somewhat resembling in texture and colour the wood above described, are occasionally found in the upper chalk, near Lewes. These closely resemble the leafy culms, or stems of plants, and are undoubtedly the remains of unknown vegetables; in some instances they are attached to portions of wood.

The imperfect state in which these remains occur, renders it impossible to determine the nature of the original. From their being associated with the supposed juli of the larch, it has been conjectured that they are the leaves of a species of *larix* or *pinus*, of which the bodies alluded to are the fruit; but as the nature of the latter is very uncertain, the coincidence may be merely accidental. It must however be acknowledged, that these remains and impressions bear a closer resemblance to the foliage of a species of *pinus*, than to that of any other vegetable with which we are acquainted.

Tab. ix. fig. 2, represents the usual appearance of the specimens.

——— fig. 12, is in all probability a flattened culm or stem, with the linear leaves surrounding it.

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[*] It seems probable that "the brown, or blackish brown substance, discovered in the Suffolk chalk, and which sometimes has the appearance of a sooty powder, and is occasionally fibrous [†]," is wood in a state of decomposition.

[†] *Phillips' Geology*, edit. 1822, p. 72.

Tab. ix. fig. 1. This appears to be the remains of a winged seed, or capsule; the black stain near it, is produced by carbonized wood.

Localities. Chalk-pits near Lewes and Brighton.

3. Unknown fossil bodies, resembling "the supposed juli of the larch." Tab. ix. figs. 3. 6. 9. 10.

These are of two kinds; the first differs but little from the bodies already described as occurring in the chalk marl at Hamsey (vide description of the chalk marl fossils); the other variety is more elongated, its surface nearly smooth, and it is solid throughout. The constituent substance of these fossils, is precisely of the same nature as the vertebræ, and other bones of cartilaginous fishes, that occur in the chalk; this resemblance is so striking, that it is with considerable hesitation I have noticed them in this place, being fully of opinion, that they may hereafter prove to be parts of fishes.

Tab. ix. figs. 9, 10, are specimens of the imbricated variety, from Steyning chalk-pits. The latter (fig. 10) resembles figs. F. G. Pl. V. of Burtin*, which are supposed by that author to be "*fruit, ou noyau de fruit inconnu.*"

——— fig. 3, represents a large example of the smooth kind, from the upper chalk, near Lewes; a more perfect specimen lately discovered, very much resembles in form *the roe of a fish.*

Tab. ix. fig. 6. This specimen is of a very singular character, and is the only known instance in which the "supposed juli" have been discovered in connexion with other remains. The substance represented at the base of the drawing, possesses the character of bone, but is too much injured to admit of its original nature being ascertained. The mutilated remains of three of the "supposed juli" are imbedded in the chalk near it; their relation to the substance in question cannot be doubted, but at present the subject is involved in obscurity, and no accurate opinion can be formed of their real nature and origin.

Localities. Chalk-pits near Lewes, Brighton, and Steyning.

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* *Oryctographie de Bruxelles.*

4. Fruit of an unknown vegetable?

A muciferous fruit has recently been found in the lower chalk, near Lewes. It is of a flattened oval form, about two inches long, and 1·5 inch wide; the surface exhibits a ligneous structure, and the surrounding chalk is tinged with a bituminous stain.

In the malm rock of Western Sussex, a few specimens of this kind, but of a small size, have been discovered near Bignor.

These fossils closely correspond with Martin's figure of the external covering of Phytolithus *nuceus**, and which, notwithstanding its diminutive size, that excellent writer was of opinion belonged to a species of *Cocos* or *Areca*.

ZOOPHYTES.

Although the remains of this class of organized beings are very numerous in the chalk, they are referable but to few genera and species. For the most part they bear scarcely any resemblance to known existing species, and in numberless instances exhibit but slight indications of the form and structure of the original. The stony corals are transmuted into calcareous spar; while the softer spongeous zoophytes are either enveloped in flint or chalcedony, or form chalky ferruginous casts and impressions.

5. Madrepora *centralis*. Tab. xvi. figs. 2. 4.

Stirps solitary, cyathiform, turbinated, or cylindrical; with numerous perpendicular, radiating lamellæ, alternately extending to the centre, where they unite; surface longitudinally striated: pedicle slightly expanded.

This species belongs to the genus Caryophillia of Lamarck; its form is exceedingly various, being either turbinate, cyathiform, or cylindrical, &c.

The specimens are usually from half an inch to two inches in length, and from 0·3 to 0·5 inch in diameter. The external surface is marked with delicate longitudinal elevations, corresponding in number with the lamellæ; the latter are perpendicular, alternately reaching to the centre of the axis, where they unite at about 0·2 inch below the margin. The intermediate lamellæ are distinct, and do not extend more than half-way towards the axis. The smaller number of the lamellæ, and the union of the larger ones, separate this species from *Madrepora cyathus* of Ellis *, to which it is nearly allied.

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* *Petrificata Derbiensia*, Plate xxi. fig. 6.

The cyathiform variety is represented, Tab. xvi. fig. 2.

The inversely conical, or turbinated, by Tab. iv. fig. 16. vol. 3. Organic Remains.

In some specimens of the elongated or cylindrical variety, a mode of growth is observable, which if not the effect of accident, might constitute a specific, or perhaps a generic character. An example of this kind is delineated in tab. xvi. fig. 4. The coral is attached by its pedicle to a fragment of chalk, and is of a regular cyathiform figure, to the extent of about an inch. From the disk of this joint, it is produced into an elongated cylindrical body, which is bent nearly at right angles with the base; a peculiarity of shape that must have resulted either from the original conformation of the animal, or from its having been displaced, and subsequently extended in a perpendicular direction.

The constituent matter of the specimens is crystallized carbonate of lime, which in some examples is translucent, and exhibits the lamellated structure of the original, in a very distinct and beautiful manner.

Localities. Brighton, and Lewes chalk-pits.

6. An unknown species of compound Madreporite.

Of the compound Madreporites, or those which consist of an aggregation of stars, a species has been discovered, that differs from any previously noticed by authors; but the specimens in my possession, are not sufficiently entire to point out the form of the original. It belongs to those corals which Mr. Parkinson has designated by the term "porpital," and occurs in fragments from one to two inches thick. It is composed of fine perpendicular lamellæ, united by very numerous horizontal dissepiments. The cells are distinct and obscurely hexagonal, and the partitions simple, as in *Madrepora retepora* of Ellis *; their cavities are filled with chalk.

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* *Ellis' Zoophytes*, tab. xxviii. fig. 7.

ALCYONIUM.

To this genus the fossil remains of zoophytes of very dissimilar characters have been referred by oryctologists. These bodies, whether convex or concave, solid or porous, simple or ramose, possessing a pedicle, or destitute of processes of attachment, appear to have been indiscriminately named *alcyonia*, whenever their relation to other established genera was not very manifest. But if we restrict the term to the fossils that agree with the Linnean definition †, and assume the A. *digitatum* as the type of the genus, the number of those which are found in a fossil state will be comparatively small. And when it is considered, that even many recent species are with difficulty distinguished from the *spongiæ* and other analogous zoophytes, it will not appear surprising, if in numerous instances the generic characters of the fossils in question, cannot be accurately determined. In this place, we shall therefore describe as alcyonia, those specimens which either in form or structure, bear even a remote resemblance to the recent species of the genus.

7. Turbinated alcyonite. Tab. xv. fig. 5.

This fossil is of an inversely conical figure, the upper part being slightly convex, and having a shallow circular cavity in the centre. The external surface is marked with several reniform depressions, but is destitute of the porous structure observable in the recent alcyonia. The constituent substance is chalk.

This specimen corresponds in many respects, with the "siliceous alcyonite," described by Mr. Parkinson, (*Org. Rem.* Vol. ii. Tab. ix. fig. 6.)

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* *Ellis' Zoophytes*, Tab. liv. fig. 3.

† Alcyonium. *Gen. Char.* Body fleshy, gelatinous, or spongy; with an external skin full of openings, possessed by oviparous tentaculated hydræ; the stirps fixed.

Tab. xv. fig. 4, represents a vertical section of a similar specimen.

Localities. Chalk-pits near Lewes.

8. Flints deriving their form from alcyonia. *Org. Rem.* Vol. ii. Tab. 12.

These are frequently met with on the ploughed lands of the South Downs, and in all probability are the remains of alcyonia enveloped in flint.

Rolled chalk flints of a depressed, subrotund, hemispherical, or oblong form, containing a body of a spongeous texture, are not unusual among the pebbles on the sea-shore; they are similar to the specimens figured by Mr. Parkinson: the substance which they enclose is evidently of alcyonic origin.

Localities. The shore at Newhaven, and along the coast to Beachy Head.

9. Bodies of a depressed, spheroidal, or subconical form, consisting of a plexus of fibres, ramifying in a spongeous mass; their constituent substance, a friable carbonate of lime.

These frequently form the nuclei of siliceous nodules.

Localities. In the upper chalk near Lewes and Brighton, and on the ploughed lands of the Downs.

10. Pyriform bodies, the nature of which is unknown. Tab. xvi. figs. 17, 18.

These fossils are of a pyriform shape, slightly furrowed longitudinally, and composed of flint, coated with a calcareous crust; when viewed through a lens, their surface exhibits a spongeous structure.

They are solid, and exhibit some indications of a pedicle or process of attachment.

Localities. In the chalk near Brighton, first noticed by Col. Birch of Bath.

11. Spongia *ramosa*. Tab. xv. fig. 11.

The remains of this fossil are probably more abundant in the flints of the upper chalk, than those of any other zoophyte. The specimens generally consist of cylindrical fragments, from 2 to 3 inches in length, and 0·6 or 0·8 inch in diameter; and very rarely possess any vestiges of branches. The present example was found in the centre of a large flint, from South street, and is the finest hitherto discovered. It is of a compressed cylindrical form, nearly eight inches long, and exhibits the remains of seven branches; yet it is evidently only a fragment of a large specimen. Its structure is spongeous, and it is destitute of an epidermis, or external covering.

This spongite appears to have been of so delicate a texture, as not to allow of its preservation in the chalk; and it is only when enveloped in siliceous nodules that any distinct traces of it remain. The constituent substance is partly siliceous, and partly calcareous, the centre being generally composed of flint, and the external spongeous mass, of a friable white or yellowish carbonate of lime. In a few instances the surface is frosted over with drusy crystals of quartz.

The specimens are for the most part either loose in the cavities of the flints, or but very slightly adherent; a circumstance that may have originated from the decay of the epidermis of the original, or from a contraction of its substance.

As this species of fossil sponge is very common, it seemed desirable to distinguish it by some appropriate name; that of S. *ramosa* has therefore been assumed as a temporary distinction.

Tab. xv. fig. 8, is the siliceous cast, or nucleus, of a fossil of this kind, the friable spongeous mass having been removed. Similar specimens are not unusual in the cavities of those nodules in which the original zoophyte has suffered decomposition, subsequently to its immersion in the flint.

Localities. In every quarry in the upper chalk near Lewes, and Brighton.

12. Branched silicified zoophytes, belonging to some unknown genus.

It is scarcely possible either by description or delineation, to convey an accurate idea of these curious fossils. They generally occur in the centre of the largest flints, and are more or less ramose. Some specimens have from four to six branches, the terminations of which appear on the surface of the nodule, in the form of annular depressions. Upon fracture, these bodies are found to consist of innumerable diverging tubuli, proceeding from one common centre, or stem, and surrounded by a spongeous epidermis. Their constituent substance is siliceous, being frequently composed of agate or chalcedony, and having a loose covering of carbonate of lime.

An analogous structure is observable in the "sand alcyonia" of Warminster Common, but the latter do not appear to possess the spongeous epidermal covering, so strikingly displayed in the former. The only recent zoophyte to which these fossils bear the slightest resemblance, is the "branched sponge from Cape Coast Castle, in Africa," figured by Ellis in the *Philosophical Transactions*, Vol. 55, Tab. 11, fig. F; but the dissimilarity between them is too great, to admit of the supposition that they belong to the same genus.

Localities. Upper chalk, near Lewes and Brighton.

13. The epidermis of a ramose zoophyte attached to a flint.

The surface is covered with minute openings regularly disposed, and when viewed through a lens, the intermediate substance is observed to be finely punctated.

This specimen belongs to a genus formed by Mr. Konig, for the reception of those fossil zoophytes that possess symmetrical openings, either round, or disposed in meshes.

Localities. Ploughed lands on the Downs.

14. Spongus[*] *Townsendi*. Tab. xv. fig. 9.

Body cyathiform, containing a conical cavity; substance spongeous; stirps fixed by radical processes.

These are the cup-like corals, or sponges, so accurately described by the late Rev. J. Townsend, of Pewsey[†]; and by Mr. Parkinson[‡], in his celebrated work on the organic remains of a former world. The usual form of the specimens is that of fig. 9. Tab. xv.

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[*] "Spongus corpus multiforme, epidermide porosa tectum, protuberantiis interdum conicis, oculiferis.—It approaches the genus *spongia*, from which it differs in being invested with an epidermis, and in having had the power of contraction; the epidermis as well as the oculi, are often destroyed in the process of mineralization." *Extract of a letter from Chas. Konig, Esq. of the British Museum, to the author.*

[†] *Character of Moses*, 2 vols. 4to. 1813.

[‡] *Organic Remains*, Vol. ii. pp. 125, 126.

The depth of the cup-like cavity is in the proportion of one-third of its longest diameter, the latter being nearly equal to the length of the entire fossil, which varies from three to eight inches. The margin, or border of the cup, is about 0·3 inch in thickness, and exposes the edge of the enclosed zoophyte. The base is perforated by several foramina, through which the processes of attachment have passed; and it is not unusual for the openings to be partially filled with the remains of these appendages. These are the only external indications of the original in the perfect siliceous specimens, the substance of the zoophyte being completely enveloped in flint, except at the margin and base; but upon fracture, sections are obtained that distinctly display its form and structure. When preserved in chalk, the porous or spongeous texture is very apparent, and these examples are more or less deeply coloured with an ochraceous or ferruginous stain*.

That the original was a zoophyte of a cyathiform shape is very clearly established; and in all probability, it bore considerable resemblance to S. infundibuliformis, or S. crateriformis†.

Localities. Upper chalk, near Lewes.

15. Spongus *labyrinthicus*. Tab. xv. fig. 7.

Body hemispherical, turbinated, or subcylindrical; the superior surface marked with flexuous depressions; base perforated.

The figure sufficiently explains the usual form of these fossils. The base has an irregular foramen for the passage of the processes of attachment. The upper surface is almost flat, and is marked with flexuous anastomosing depressions, surrounded by a circular or elliptical indentation, that forms the outer margin. These markings are produced by the edge of the porous substance enveloped in the flint, which is evidently the remains of a zoophyte of the genus *Spongus*.

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* Mr. Townsend remarks, "that many of these fossils are compressed, and others have their margin folded back without being fractured; on the other hand, there are numbers which have evidently been fractured and have sharp edges. The former are probably sponges of the infundibuliform species; the latter, I am persuaded, are cup-corals. Such were the corals of M. Guettard, as appears by the Memoirs of the Academy of Paris for the year 1751."

† There are several recent sponges that possess a cyathiform figure, viz. *Spongia infundibuliformis*, *Wernerian Transactions*, Vol. 1, p. 562. *S. crateriformis*, *Pallas*, *Zooph.* p. 386. *S. scypha*, *Wernerian Trans.* Vol. 2, p. 107. The shape of the last mentioned is that of an inverted cone, with a very short stalk, which is of a corky nature internally, but porous superficially, like the other parts; the hollow spreads like the bowl of a wine glass, becoming smaller at the bottom.

The body is from one to three inches in length, apparently smooth, but giving that peculiar sensation of roughness to the touch, which is considered by Mr. Parkinson, as characteristic of the fossil remains of the spongiæ and alcyonia.

Some specimens are solid, others hollow, or partially filled with a light porous mass; and in numerous instances the interior is lined with mamillated chalcedony of an azure colour.

Localities. Upper chalk, near Lewes.

16. Cylindrical bodies enclosed in flints.

These are the remains of unknown zoophytes, in which but few traces of organization are preserved. They are of a cylindrical form, from one to six or eight inches in length, and about half an inch in diameter. They consist of flint, and are invested with a thick covering of the same: the interval between the surrounding flint, and the enclosed fossil, being either hollow, or filled with a chalky porous substance, in all probability the decomposed remains of the epidermis of the original. In one specimen the cylinder is traversed by longitudinal tubes.

Localities. Very abundant in the chalk, and on the ploughed lands near Lewes.

17. A compressed zoophyte, having a finely reticulated surface.

The remains and impressions of this fossil are invariably of a ferruginous colour, and are of frequent occurrence in the chalk. The specimens are from 0·1 to 0·2 inch in thickness, and extend in the manner of the *gorgoniæ*, oftentimes covering a space of six or eight inches square; but no perfect example has hitherto been discovered. Both the external and internal surface is covered with minute pores, regularly disposed, which when viewed through a lens, prove to be the meshes or openings of a reticulated plexus of fibres; the intermediate substance is composed of chalk, and exhibits no traces of organic structure. The impressions of this fossil form a surface covered with minute papillæ, that have been moulded in the meshes or interstices of the reticulated integument.

There is no recent genus to which this zoophyte can with propriety be referred; it approaches in some respects to the *gorgoniæ*, and in others, to the *flustræ*, but possesses characters that separate it from both*.

Localities. Upper and lower Chalk, near Lewes, and Brighton.

VENTRICULITES.

This genus has been instituted by the author, for the reception of a numerous and highly interesting division of fossil zoophytes, whose remains have usually been confounded with the spongiæ, alcyonia, and other analogous genera.

The first specimen submitted to my notice, was the elegant flint, delineated in tab. x. fig. 5; it was collected many years since by my esteemed friend, Thomas Woollgar, Esq. of Lewes, and was supposed to be a petrified mushroom, or some other species of agaric. A slight examination, however, convinced me that its form was derived from some unknown zoophyte; and being very desirous of ascertaining the nature of the original, I shewed the specimen in question, to the workmen employed in the chalk-quarries near Lewes, and by exciting their industry with suitable rewards, soon formed an extensive collection of these curious bodies. But the refractory nature of the silex in which they were enveloped, prevented the acquirement of any satisfactory information; the sections produced by fracture merely proving, that the enclosed zoophyte was of a cyathiform shape, and possessed processes of attachment at the base.

Early in the ensuing year, a broad circular fossil, with a reticulated surface, was discovered in a block of chalk, on the road-side near Ringmer;

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* It very closely resembles a fossil in the British Museum, marked "*Flustra, from New Holland.*"

but this appeared to differ so essentially both in form and structure, from the funnel-shaped flints above mentioned, that their relation was not suspected. Notwithstanding the investigation was continued with but little intermission, nearly two years elapsed before any additional light was thrown upon the subject; when the fortunate discovery of the fossils represented in Tab. xi. (in which the inferior portion of the zoophyte is enveloped in flint, and the upper part displayed on the surface of the chalk) proved most decidedly the identity of the chalk, and flint specimens.

In the year 1814, I presented a brief description of these fossils (accompanied with explanatory drawings) to the Linnean Society, which was honoured with a place in the 11th volume of its Transactions. In that paper the name of *alcyonium chonoides*, (funnel-shaped alcyonium) was proposed as a temporary distinction, "till future discoveries should point out more precisely its situation in the scale of animated nature[*]." Numerous examples have subsequently been discovered, which not only confirm the opinions therein advanced concerning the probable structure of the original, but also demonstrate the existence of characters sufficiently remarkable to be assumed as generic distinctions. The propriety of forming the present genus, it is therefore presumed, will be readily admitted.

18. Ventriculites *radiatus*[†]. Tab. x. xi. xii. xiii. xiv.

Gen. Char. Body inversely conical, concave, capable of contraction and expansion: original substance spongeous? or gelatinous? external surface reticulated; internal surface covered with openings or perforated papillæ; base imperforate, prolonged into a stirps, and attached to other bodies.

Spec. Char. Infundibuliform; external integument composed of cylindrical, anastomosing fibres, radiating from the centre to the circumference; inner surface covered with perforated papillæ, formed by the open extremities of short transverse tubuli; stirps fixed by radical processes.

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[*] *Linnean Transactions*, Vol. XI. p. 401.

[†] In my geological correspondence, I have been accustomed to distinguish this species by the specific name of *choniformis*, but as the funnel-like form is common to the whole genus, the term is manifestly improper; that of *radiatus* is here substituted, the radiating manner in which the fibres of the external integument are disposed, appearing to be peculiar.

So numerous are the accidental varieties of form assumed by the fossil remains of this species, that it is difficult to distinguish them correctly, without the assistance of an extensive suite of specimens. This circumstance is partly attributable to the various states of expansion and contraction, in which the originals were introduced into the mineral kingdom; and partly to the mode in which their remains are occasionally preserved.

The specimens enveloped in flint, are usually of a cyathiform, or turbinated shape (vide Tab. x.); while those imbedded in chalk, are more or less expanded in the form of a broad circular disk, as in Tab. xiv. The external surface is composed of cylindrical fibres, that extend in a radiating manner from the centre or base, to the outer margin, and by frequently subdividing and anastomosing, constitute a reticulated integument capable of very considerable contraction and expansion. Vide Tab. xii. figs. 1, 2. Tab. xiii. figs. 2, 3, 4, 5. Tab. xiv. fig. 2.

The fibres are solid*, and when viewed through a lens, exhibit a porous structure, bearing considerable resemblance to dried sponge. The meshes, or interstices between the fibres, are narrow and elongated in the specimens that are expanded, but very irregular in those which are corrugated by contraction. In some instances slender transverse filaments extend from one fibre to another, by which the entire plexus is more firmly connected together; these are represented in the magnified sketch, fig. 6, Tab. xiii. The surface of the interior, or funnel-shaped cavity, is studded with small perforated tubercles, or papillæ, the open extremities of short, straight, cylindrical tubes, that arise between the fibres of the external integument, and passing in a transverse direction, terminate on the inner surface. Siliceous casts of these tubuli, are frequently observable in flints deriving their form from ventriculites. (vide the edge of the flint represented in Tab. x. fig. 13.)

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* A different opinion is entertained by Miss Benett, who assures me, that in several Wiltshire specimens in her possession the fibres are hollow. I have not, however, been able to detect such a structure in any of the numerous examples that have been submitted to my examination.

The base forms an elongated stem or stirps, and terminates in diverging root-like processes, by which the original was fixed to other bodies; these are shewn in the specimens represented Tab. xi. fig. 2, and Tab. xii. fig. 2.

This zoophyte, when contracted into a cylindrical form, is from one to six inches in length; when expanded, its diameter occasionally exceeds nine inches: the thickness of its substance is seldom more than 0·2 inch.

Tab. x. represents various flints whose forms are derived from V. *radiatus.*

Fig. 1. This specimen is partially expanded, and its margin exposes casts of the tubuli, as previously mentioned; the base is perforated by fifteen openings, through which the processes of attachment passed out. A plate of an echinus is attached to the inferior part of the stem.

Figs. 2, 3, 4. Small turbinated flints, formed in the stirps or base of the funnel-like cavity; (vide description of Fig. 2, Tab. xi).

Fig. 5. This elegant flint was discovered by my friend Mr. Thomas Woollgar. The margin is marked with semilunar indentations, the impressions of the fibres of the external integument; a similar appearance is observable on the edge of fig. 9. These markings are peculiar to the fossils of this genus, and attention to this circumstance will frequently enable the collector to distinguish the siliceous specimens of *ventriculites,* from those of *Spongus Townsendi.*

Fig. 6. This specimen is inverted in the engraving; it is hollow, the zoophyte it formerly enclosed having been removed. The upper part (the base of the original) has numerous openings formed by the transit of the radical processes.

Fig. 7. A transverse section of a flint enclosing the stirps.

Fig. 8. The thickness of the margin of this specimen, has evidently been produced by the contracted state of the original, at the period of its immersion in the flint.

Fig. 9. Represents a specimen viewed from beneath.

The specimens above described exhibit no traces of organization, except at the margin and base, the outer surface of the original being obscured by the silex, in which it is imbedded. In some examples, however, the enclosed zoophyte may be separated from the surrounding flint by a well-directed blow on the margin, and very delicate casts and impressions may be thus obtained.

The former exhibit the external integument changed into a white friable carbonate of lime; the latter form conical cavities covered with numerous interrupted ridges, disposed in a radiated manner.

The casts of the funnel-shaped cavity are solid cones; their surface exhibiting numerous minute papillæ, that have been moulded in the open extremities of the tubuli. A chalk specimen of this kind is figured by Lhwyd, No. 176*: but it is drawn in an inverted position.

Tab. xi. The fossils here represented are remarkably interesting, since they tend to elucidate the formation of those above mentioned, and establish the identity of the chalk and flint specimens.

In fig. 1, a conical flint fills up the lower half of the funnel-like cavity, and is surrounded by the impression of the external surface of the upper portion.

In fig. 2, the stem is occupied by a small turbinated flint, that sends off several radical processes from its base. The dissimilarity in the size and shape of these flints is purely accidental, arising from a greater proportion of silex having been deposited in the one instance, than in the other. Hence we may infer, that if in either example the quantity of silex had been sufficient to have filled the entire cavity, the flints thus formed would, in every particular, have resembled those delineated in the preceding tablet, figs. 1. 5. 9.

Among the singular forms assumed by the siliceous specimens of ventriculites, none are apparently more difficult of explanation, than the broad annular flints occasionally found on the ploughed lands of the Downs, and which bear considerable resemblance to a coit; their origin is however satisfactorily illustrated by the specimen, fig. 1. Tab. xii. In this example, the ventriculite is inverted, and attached to the chalk by its inner surface, the outer integument forming a narrow zone round the annular flint, which in the perfect state of the fossil encircled the stem; as is shewn in the annexed sketch.

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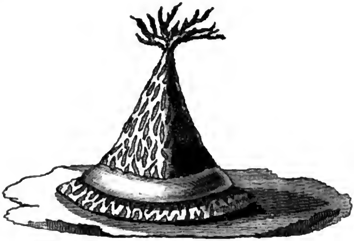
* It is thus described, "Astroitæ congener *radularia* cretacea. E puteis cretaceis juxta *Aston Lowant* in agro Oxoniensi." *Lhwyd, Lith. Britt.*



The appearance of this specimen seems to warrant the conclusion, that at the period of its mineralization, the silex was in a state of a thick viscid fluid, otherwise it is difficult to understand why it should not have extended to the margin of the zoophyte, instead of being consolidated in its present situation. The cyathiform flint, fig. 1. Tab. x. might also be adduced in support of such an opinion, since the silex not only fills the cavity of the ventriculite, but is elevated considerably above the margin, as if a pulpy or glutinous fluid had been gradually poured in, till the cup-like cavity was overflowing.

Tab. xii. fig. 2, exhibits the external surface of a ventriculite, attached to a block of chalk; the impressions of numerous radical processes are seen at the base.

Tab. xiii. fig. 1. The upper part of a ventriculite preserved in flint, the side of the cavity being somewhat collapsed.

Figs. 2, 3. 5; chalk specimens of the stem or inferior part; the moniliform appearance of the fibres is probably the result of contraction *.

Fig. 4. A ventriculite attached to a block of chalk. The lower part is enveloped in flint, but a fracture near the base exposes a portion of the enclosed zoophyte; the upper portion is preserved in chalk, and exhibits the reticulated structure of the external integument.

Fig. 6. A magnified view of part of the external surface of fig. 2, shewing the lateral filaments or processes.

Tab. xiv. represents two chalk specimens of *Ventriculites radiatus*, the animal in both instances being completely expanded. Fig. 1 exhibits the inner surface covered with perforated papillæ; fig. 2 the external surface with its reticulated integument. The radical processes are not seen in this example, having been unavoidably removed with the surrounding chalk.

In concluding this description, it may be proper to offer a few remarks on the probable economy of the recent animal, and from the facts that have been presented to our notice, endeavour to illustrate the nature of the original.

From a careful examination of a numerous and interesting suite of specimens in my possession, the structure of the recent ventriculite may be readily understood. The general form of the animal appears to have been that of a hollow inverted cone, having numerous ramose fibres proceeding from the base, by which it was attached to other bodies. Externally it was composed of a muscular reticulated integument, capable of expanding and contracting, according to the impressions it received; and internally it possessed a surface covered with the apertures of numerous tubuli, in all probability the openings of absorbent vessels, by which its nutrition was effected.

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* The flint represented in *Sowerby's British Mineralogy*, Tab. 215, fig. 3. is a siliceous specimen of the stirps of this species; but it is drawn in an inverted position: the perforations in the upper part of the figure, are the apertures through which the radical processes passed.

These inferences naturally present themselves, even upon a slight inspection of the fossils above described. It has already been shewn that the specimens occur in every intermediate form, between that of a simple elongated cone, and a flat circular disk; hence it is obvious, that the substance of the original must have been soft and elastic, susceptible of spontaneous expansion and contraction, or it could not have accommodated itself to such a variety of shapes, without fracture or laceration. The fibres composing the external integument, are nearly straight in the expanded specimens, but are corrugated and moniliform in those which are contracted; the thickness of the latter is also much greater than in the former examples;—circumstances that strongly corroborate the opinion here advanced.

The expanded state of the animal, might be favourable for the discovery of the substances destined for its nutriment, and which by its subsequent contraction, would been closed in its funnel-like cavity. Whatever may have been the nature of its aliment, it seems probable that it underwent a certain degree of digestion and assimilation before it was fitted for its support; and that the nutritious particles were taken up by the openings so numerously distributed on the inner surface of the ventricular cavity.

Whether the recent ventriculites were confined to one spot, or possessed a certain degree of locomotion, and by detaching their radical processes, were able to change their situation by floating in the water, cannot with certainty be determined; but it seems more probable, that, like the *alcyonia*, and *actiniæ*, they were permanently fixed to the rock upon which they grew.

The annexed outlines will perhaps serve to render the subject more intelligible than mere description.

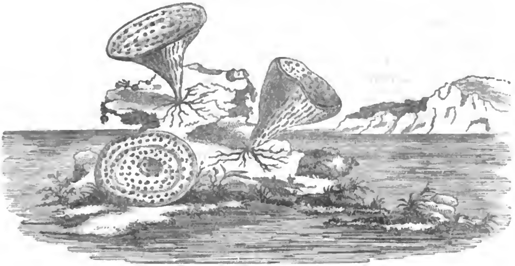

Fig. *a.* A ventriculite in an expanded state, shewing the inner surface.

Fig. *b.* A specimen partially contracted, exhibiting the external integument.

Fig. *c.* A ventriculite more expanded, and exposing the internal cavity.

From what has been remarked, I am therefore led to conclude that the ventriculites were more nearly related to the actiniæ[*], than to the

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[*] The following interesting fact was communicated to me by GEORGE CUMBERLAND, Esq. of Bristol, (a gentleman well known for his various communications on subjects connected with Geology); and as it offers a pleasing illustration of the manner in which the nutrition of the softer zoophytes is effected, it is here inserted.

A few years since, in the summer season, Mr. Cumberland was on a visit at ——, and during a ramble on the sea-shore, his attention was arrested by a group of the *Actinia mesembryanthemum,* (*Ellis' Zoophytes,* page 4,) attached to a rock, left bare by the recession of the tide. While examining these curious objects, a fisherman who stood near, observed that "they sea flowers were strange things, for they lived upon sprats, and fed only once a year;" and upon Mr. C. expressing his surprise at the remark, his informant assured him that the fact was indisputable, and might be easily verified in the sprat season. Determined to investigate the subject, Mr. C. marked the spot to which the zoophytes were attached, and upon revisiting it in the autumn of the following year, *the small disciform actiniæ were no longer to be seen, but their place was occupied by several elongated cylindrical bodies, several inches in length, and without any perceptible aperture. He immediately detached one of them from the rock, and upon* alcyonia; and that each individual was a perfect animal*, capable of performing those motions which were necessary for its preservation and subsistence.

Localities. Upper chalk, near Lewes and Brighton.

19. Ventriculites *alcyonoides*. *Org. Rem.* Vol. ii. Tab. x. fig. 12.
———————— *Smith's Strata*, Tab. iii. fig. 1.

Spec. char. Conical when contracted, disciform when dilated; meshes of the external surface nearly circular, filled with small radiated (?) pores or openings; inner surface covered with papillæ: stirps fixed by radical processes.

This species is rare in Sussex, but common in a contracted state at Heytesbury, in Wiltshire; the expanded specimens are of less frequent occurrence.

The external integument is finely reticulated, the meshes or openings being very numerous, and almost circular; a structure by which the present species may be easily distinguished from V. *radiatus*.

In some siliceous specimens, the meshes are filled by little cells or pores, having a central opening, and surrounded by radiating lamellæ, which are rendered evident, by a lens of moderate power; these in all probability, are the external orifices of tubuli that pass through the substance of the zoophyte, and terminate in the papillæ of the inner surface.

It is a small species, seldom exceeding two inches and a half in length.

The impressions both of the outer and inner surface are conical, and studded with papillæ; but the former are concave; the latter, solid and convex. The difference in the form of this ventriculite when in an

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slitting it open, found that it contained the remains of a sprat, (Clupea sprattus) in a partially digested state; and that these unknown bodies were in fact the actiniæ, enormously distended. Subsequent observations convinced him, that after a certain period the animal rejected the undigested remains of the fish, and subsequently contracted into its original shape; remaining in a quiescent or torpid state till the next season, when its annual repast was renewed.

May not the nutrition of the ventriculites have been effected in a similar manner?

* Mr. Miller thinks this opinion is erroneous, and that each ventriculite should be regarded as an aggregation of polypes.

expanded and contracted state, is very analogous to what has been noticed in the shape of the recent *actinia mesembryanthemum* under similar circumstances, (vide note in page 175.)

Smith's figure is an excellent representation of the usual appearance of the outer surface of the conical specimens. Mr. Parkinson's resembles a cast of the interior; he describes it "as being composed of chalk, and having somewhat of a conical figure, the surface closely beset with small depressions pretty regularly disposed in a quincuncial order."

Localities. Upper chalk, near Lewes.

20. Ventriculites *quadrangularis*. Tab. xv. fig. 6.

Spec. Char. The animal capable of contracting itself into a quadrangular form; the meshes of the external integument circular, very minute; inner surface ——? Stirps ——?

The specimen represented is the only one hitherto discovered; the quadrangular form into which it is collapsed distinguishes it from every other species.

Locality. Upper chalk, Offham.

21. Ventriculites *Benettiæ*. Tab. xv. fig. 3.

Spec. Char. Inversely conical; meshes of the external integument oblong, irregular, rather distant; inner surface covered with circular depressions; margin of the cavity broad, smooth, and nearly flat; base fixed by radical fibres.

The form and appearance of this species are so well expressed in the engraving, that a brief description will suffice. It is distinguished by the large, irregular, oblong meshes, of the reticulated surface, and the broad smooth border of the ventricular cavity [*]. The lower part of the specimen figured is siliceous, and a radical process is seen issuing from the base.

I have named this beautiful species in honour of Miss BENETT, of Norton-house, near Warminster, Wilts; a lady of great talent, and indefatigable research, to whom I am under infinite obligations, for many valuable communications on scientific subjects.

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[*] It must, however, be remarked, that the thickness of the parietes of this species, renders it probable that its powers of contraction and expansion were very inconsiderable: in this respect, it resembles the *choanites*; but the reticulated external integument, and the structure of the inner surface, seem to warrant its being retained in the present genus.

Localities. Upper chalk, near Lewes; very rare.

CHOANITES.

Gen. Char. Form various, generally either funnel-shaped, spherical, globular, or subcylindrical, having a central opening in the superior part; the original composed of a parenchymatous substance, capable of imbibition and contraction; the base fixed.

The fossil zoophytes which this genus is intended to comprehend, are very numerous, and hold an intermediate place between the *alcyonia*, properly so called, and the *ventriculites*. They are distinguished from the former by the central cavity in their superior part, and from the latter, by being destitute of an external reticulated integument, &c. and possessing but a slight degree of contractile power.

The *alcyonium ficus* of Linné (*figure de substance et d'eponge et d'alcion*, of Marsilli) may be considered as the type of the genus. "It is of the form of a fig, being attached to the rocks by branches proceeding from its smaller end; the upper part is a little flattened, and has a cavity in the middle. Its colour resembles that of tobacco, and its parenchymatous substance cannot be compared to any thing better than to nutgalls when well dried *."

The fossil remains of this genus, (hitherto indiscriminately placed among the alcyonia) were first noticed by M. Guettard at Verest, and at Montrichard in Touraine, and form the subject of a paper published in the *Memoirs of the Academy of Sciences* at Paris (ann. 1757). He observes, that they are of a globular form, having the base in many examples elongated into a pedicle. In the centre of the superior part is a circular opening, generally filled "with the substance in which the fossils are imbedded. This cavity is larger in its upper than in its lower part, and is continued almost to the pedicle, in some specimens appearing to penetrate it. From the circumference of the opening, lines may be traced, that not only pass over the whole of the spherical part, where they form striæ more or less distinct, but also penetrate the substance of the zoophyte. There is seldom more than one opening, but instances have occurred in which there were three *." The fossils represented in Pl. ix. figs. 1, 3, 4, 6? 8. and Pl. xi. fig. 8, *Org. Rem.* Vol. ii. belong to this genus.

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* *Organic Remains*, Vol. ii. p. 96.

22. Choanites *subrotundus*. Tab. xv. fig. 2.

Depressed, subrotund; central cavity small; external surface smooth.

This species is generally termed " ficoid alcyonite" by collectors, from its supposed resemblance to a fig. The surface is smooth, and wholly destitute of markings; the cavity nearly circular. The depressed form of the specimens is probably owing to compression.

In the specimen figured, three of these bodies are attached to a block of chalk, of which substance they are composed.

Localities. Upper chalk, near Lewes.

23. Choanites *flexuosus*. Tab. xv. fig. 1.

Cyathiform, margin of the central depression marked with flexuous indentations. The radical processes long, and fibrous; base fixed by radical processes.

The specimen figured is enveloped in flint.

Localities. Upper chalk, near Lewes: very rare.

24. Choanites *Konigii*. Tab. xvi. figs. 19, 20, 21.

Inversely conical, externally marked with irregular fibres, some of which penetrate the substance, and terminate in openings on the inner surface; central cavity cylindrical, deep, narrow; base fixed by radical processes.

This species is for the most part enveloped in large irregular flints, which exhibit but slight traces externally, of the body they enclose. The superior part (fig. 19) presents a convex surface, with a cylindrical body in the centre, from whence interrupted fibres, slightly relieved, ramify in a radiating manner towards the margin. At the base, numerous perforations are observed, affording a passage for the radical processes. The vertical section (fig. 20) exposes the cylindrical cavity filled with silex; and the substance of the zoophyte traversed by numerous fibres, (or tubes?) some of which appear to terminate on the outer, and others, on the inner surface: these are still more distinctly shewn in the horizontal section, fig. 21.

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* *Organic Remains*, Vol. ii. p. 81.

Mr. Parkinson represents a very fine example (*Org. Rem.* Vol. ii. Tab. ix. fig. 1.) of the outer surface, in which the fibres are more regularly disposed than in the Sussex specimens.

The species is named in honour of Charles Konig, Esq. of the British Museum.

Localities. Common among the loose flints, beneath the turf, near Lewes Race-course. It appears to have been abundant in the upper beds of the chalk, but seldom occurs in our quarries.

25. Lunulites? Tab. xvi. fig. 22, 23, 24.

The fossils here represented, are convex above, and concave beneath. The concavity is smooth, with the exception of a few circular markings which appear like lines of increase: the convex side is rough, and when viewed through a lens, exhibits a porous structure. The specimens are solid; their constituent substance, a spathose carbonate of lime.

These bodies, in their general appearance, resemble a species of *lunulites* from Bologna, which Mr. Konig, from the perforations on its surface, has named *L. digitale;* but they are destitute of the diverging radiated sulci on the concave part, and these appear to be an essential character of the genus *.

Fig. 22. Perspective view of a specimen placed on its apex; fig. 23, the base or concavity; fig. 24, a lateral view.

Localities. Upper chalk, South-street, Lewes.

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* Lunulites. Char. Gen. " Polypier pierreux, libre, orbiculaire, aplati, convexe d'un côté, concave de l'autre. Surface convexe, ornée de *stries rayonnantes* et de pores entre les stries: des rides ou des sillons divergens à la surface concave." *Animaux sans Vertèbres,* Tom. ii. p. 194.

ENCRINITES AND PENTACRINITES[*].

This name has long been applied to the petrified skeletons of those zoophytes that possess a pelvis or basin, composed of an immense number of crustaceous articulated plates, and ossiculæ[†], supported by a jointed flexible column.

The pelvis, which originally contained the viscera of the animal, is surrounded by long jointed arms or tentaculæ, and affixed to the vertebral column, by a pentagonal plate placed in the centre of the base.

The column, in most species, is of an immense length, and consists of separate joints or vertebræ, regularly united, pierced in the centre, and having their articulating surfaces ornamented with radiating, stellular, or floriform markings. The inferior part of the column has a pedicle, or process of attachment, by which the animal was fixed to other substances[‡].

In the recent state, the skeleton was in all probability clothed with a fleshy, or coriaceous integument; the central perforation in the vertebral column, is supposed by Mr. Martin, to have been filled with a medullary substance, by which sensation was conveyed to the inferior extremities of the animal[§]; but according to Mr. Miller, it served as an alimentary canal[‖].

The detached vertebræ are known to collectors by the name of *trochitæ;* and when several are united together, so as to form part of a column, the series is termed an *entrochite.*

The remains of this family of zoophytes, so rarely occur in the chalk formation, that portions of two or three species, are the only examples hitherto found in Sussex. Of these the most important is the *bottle encrinite* of Parkinson, (*Apiocrinites* of Miller,) which we shall now proceed to examine.

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[*] In the *encrinites*, the bones of the vertebral column are circular or elliptical; in the *pentacrinites* they are angular or pentagonal.

[†] Mr. Parkinson has shewn, that upon a moderate calculation, the lily encrinite must have been composed of nearly thirty thousand distinct bones. *Org. Rem.* Vol. ii. p. 181.

[‡] For a more particular account of the natural history of this extraordinary tribe of animals, consult the 2d vol. of *Parkinson's Organic Remains;* and *Miller's Natural History of the Crinoidea, or, Lily-shaped Animals;* 1 vol. 4to. 1821; a work that has been justly characterized by an eminent writer, as "a model of patient, sagacious, and successful research."

[§] *Martin's Syst. Arrangement*, p. 209.

[‖] *Miller's Crinoidea*, p. 11.

26. Apiocrinites *ellipticus*. Tab. xvi. figs. 3. 12.
——————— *Miller's Crinoidea*, p. 34.

"A crinoidal animal, having a column composed of oval joints, articulating by a transversely grooved surface; the two upper joints of the column enlarged, sustaining the pelvis, costæ, &c. The column provided with auxiliary side arms. Base formed by numerous irregular columnar joints, sending off fibres for adhesion to other bodies." (*Miller's Crinoidea*, p. 33.)

The different parts of this animal were first described by Mr. Parkinson, under the various names of bottle, straight, and stag's horn encrinite; and have since been accurately investigated by Mr. Miller, who considers them as belonging but to one species, which he has placed in his first division of the *Crinoidea;* in the same genus with the celebrated *Pear encrinite* of Bradford.

The column of this species consists of smooth ossiculæ, somewhat enlarging in the middle; their articulating surfaces being elliptical, finely granulated, and having two narrow transverse ridges, in the centre of which is the small perforation containing the alimentary canal.

The pelvis or body, is of a tumid utricular form, and is divided into separate ossiculæ of various shapes, to which the names of ribs, clavicles, and scapulæ, &c. have been applied by the authors above quoted.

The specimens in my possession, were discovered too late to admit of insertion in the engravings.

The entrochites delineated in Tab. xvi. do not exhibit the transverse ridges generally observed on the areæ of the columnar joints, but in other respects they perfectly correspond with those of the present species.

Fig. 3, consists of sixteen vertebræ, some of which are partially disunited; the articulating surfaces are smooth and even, the central perforation very small. From the diminutive size, and elongated form of this specimen, it may probably be a portion of the side-arms, or lateral appendages.

Fig. 12, is composed of eight ossiculæ; and is evidently part of the vertebral column of the present species.

27. Part of the vertebral column of a pentacrinite.

This specimen is formed of eleven thin pentagonal vertebræ, with markings on their articulating surfaces, precisely similar to those represented in Tab. xiii. fig. 64, *Org. Rem.* Vol. ii.

28. A single vertebra, of a quadrangular form, the angles rounded, the surface ornamented with figures resembling a floret of four rays.

The entrochite, No. 1170, of Lhwyd, is composed of ossiculæ, perfectly resembling the specimen here described. Trochitæ of four rays are very rare; Mr. Parkinson mentions that he had seen but one (fig. 59, Tab. xiii. Vol. ii. *Org. Rem.*) and that is very dissimilar to the fossil in question.

MARSUPITES.

This genus is formed for the reception of a fossil that has hitherto been placed among the encrinites, from which however, it differs most essentially, in being destitute of a vertebral column, and processes of attachment; hence it is obvious, that the recent animal, instead of being fixed to one spot, was capable of locomotion, and floated *ad libitum*, like the Medusæ and some other zoophytes.

Mr. Parkinson, whose publication on the *Organic Remains of a former World*, forms an important era in oryctological science, was the first author that accurately noticed these interesting remains. In his 2d vol. an admirable description is given of the pelvis of the animal, under the name of *tortoise encrinite;* and very recently, the structure of the original has been ably illustrated by the ingenious author of *The Natural History of the Crinoidea*, who has adopted the name by which I have been accustomed to distinguish it.

The following definition is the result of an attentive examination of more than a hundred specimens; but as the recent animal is unknown, and the fossils never occur in a perfect state, it is very probable that some of those characters which are here assumed as permanent distinctions, may hereafter prove to be only accidental varieties of form.

29. Marsupites *Milleri.* Tab. xvi. figs. 6, 7, 8, 9, 13, 14, 15.

Gen. Char. Body orbicular, contained in a pelvis composed of crustaceous plates, having five articulated arms or tentaculæ proceeding from the margin: the opening of the pelvis covered by articulated ossiculæ, in the centre of which the mouth is placed.

Spec. Char. Pelvis composed of sixteen convex, radiated, angular plates; the arms dichotomous, united to the margin by a corresponding number of intermediate semilunar bones: the ossiculæ covering the aperture of the pelvis disposed in a proboscideal form.

The fossil remains of this zoophyte have hitherto been found only in the upper chalk of Sussex, and Wiltshire, and like most other crustaceous bodies enclosed in that deposit, are transmuted into a spathose calcareous spar.

But one species is known; the following description will therefore illustrate both the generic and specific characters:

This fossil is generally of a suborbicular form, more or less distorted, with the lower extremity closed and obtuse, and the upper, truncated and open, being filled with chalk or flint. It is composed of numerous thin angular plates, that are not united as in the echinites, but are simply held in apposition to each other, by the chalk in which they are imbedded. The name of "*cluster stones*" given them by the workmen, not inaptly expresses their general appearance.

The pelvis, or cavity in which the viscera of the animal were contained, is very capacious, and is composed of sixteen angular, convex plates, arranged in the following manner, viz.

1. A pentagonal plate (*abdominal*) placed in the centre of the base.
2. Five pentagonal (*costal*) plates, attached to the sides of the centre.
3. Five hexagonal (*intercostal*) plates, placed between the superior angles formed by the union of the costal.

4. Five pentagonal (*scapular*) plates, filling up the angles in the superior margin of those last described, each having a semilunar depression on their marginal edge: these form the margin of the pelvis, properly so called.

These sixteen plates are succeeded by

5. Five semilunar ossiculæ (*clavicles*), attached to the articulating depressions of the scapular plates.

6. Five cuneiform ossiculæ (*cuneiform* or *humeral bones*,) attached to the clavicles. These are the first bones of the arm, and their superior edge is divided into two articulations, from which the tentaculæ are sent off.

7. Numerous reniform ossiculæ, by which the aperture of the pelvis is closed.

The plates of the pelvis are convex, sometimes umbonated in the centre, and ornamented with radiated ridges on the external surface. Their markings vary in different examples, and even in the same individual; specimens occurring in which some of the plates are nearly smooth, and others richly ornamented.

Fig. 13. Tab. xvi. represents a plate, with prominent ridges extending from the centre to the angles, the intermediate surface being covered with numerous diverging striæ. In fig. 14, the centre is slightly umbonated, and the markings are coarser and less regular than in the former variety; the ridges are obtuse, and the diverging striæ few and irregular.

The plates in fig. 15 are perfectly smooth, with the exception of a few folds near the margin.

In every instance, however, the edges of the plates are more or less crenulated, and when united form a suture in the same manner as the scales of the tortoise, but they readily separate when the chalk is removed. The central or *abdominal* plate is larger, and more depressed, than the surrounding *costals;* the latter are readily distinguished by their *pentagonal*, and the intercostals by their *hexagonal* form. The *scapulæ* are generally less ornamented than the rest of the series, and are easily identified by the semilunar cavity in their upper edge; this articulating surface is traversed by a longitudinal ridge, with a minute depression in the centre, and is adapted for the reception of the clavicles.

The *clavicles* are small, and of a semilunar form externally; the upper edge is thick, nearly straight, and unites with the *humerus;* the lowermost is rounded, and corresponds with the semilunar cavity of the scapula; between these two surfaces, on the inside, is a triangular space, the use of which is not at present known.

The *cuneiform* or *humeral* bones, may be considered as the first of the arms; they have four articulations, and are attached to the clavicles by the two lowermost. Their upper margin forms two oblique surfaces, each divided by a longitudinal ridge, in the same manner as the first joint of the finger in the Bradford encrinite *(apiocrinites rotundus)*. From this structure it may be inferred, that the arms were dichotomous, but whether they were subdivided, and terminated in elongated tentaculæ, as in the *crinoidea,* cannot be ascertained, since none of the specimens contain any vestiges of the ossiculæ of these appendages. On the inner surface of the humerus, a smooth space is observable, appearing like a continuation of the triangular interval, on the corresponding part of the clavicle: is this the articulating surface for the attachment of the pectoral bones?

The *reniform ossiculæ,* or *pectoral* bones, are united to each other by their upper and under surfaces, both of which are divided by a ridge into two depressions. In the only specimen, (Tab. xvi. fig. 6.) in which these bones remain, the respective parts have suffered so much displacement, that their mode of arrangement is no longer distinguishable; there is, however, reason to conclude, that in the recent animal they were attached to an epidermis extending over the cavity of the pelvis in the form of a proboscis, the mouth being placed in the centre.

From this examination of the skeleton of the marsupite, it is evident that the recent animal was nearly related to the crinoidea; but the absence of the vertebral column separates it most decidedly from that tribe.

It may however, as Mr. Miller observes, be considered as forming a link between the *crinoidea articulata* and the *stelleridæ.*

The folds, radiating ridges, and striæ on the plates, and the lateral adhesion of plate to plate by simple sutures, plainly indicate that the whole were invested by a muscular integument; the markings on the plates being the effects of its action*.

From the rudiments of the arms, it is also equally obvious, that the recent animal was furnished with tentaculæ, to enable it to seize and detain its prey, in the same manner as the encrinites, &c. Its position when floating in the water, was in all probability with the mouth downwards, like the *Medusa pulmo*, *M. campanulata*, and other species of that family.

The specific name is in commemoration of the valuable researches of my friend J. S. Miller, Esq. A.L.S. of Bristol; a tribute of respect, to which his able investigation of the *Natural History of the Crinoidea*, justly entitles him.

Tab. xvi. fig. 6. represents the only specimen in which the reniform, or pectoral ossiculæ remain; but the plates have suffered so much displacement from compression, that their relative situation is not very obvious, without careful examination. It does not however appear probable, that the proboscideal form in which the pectoral bones are disposed, is the effect of accident, since a similar structure prevails in the *actinocrinites*†, and several other zoophytes. A clavicle united with one of the humeral bones, is seen attached to the scapula, near the middle of the figure.

——— fig. 7. The semilunar depression on the upper margin of a scapula.

——— fig. 8. Outline of the clavicle.

——— fig. 9. A clavicle and humerus united.

——— figs. 13, 14. Detached costal plates; the one finely striated, the other with obtuse ridges.

——— fig. 15. The entire pelvis, consisting of the abdominal, costal, intercostal, and scapular plates. Specimens of this kind, more or less distorted, are the only parts of the animal generally found; the clavicles, humeral bones, &c., are among the rarest productions of the chalk formation.

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* *Miller's Natural History of the Crinoidea*, p. 137.

† Vide *Nat. Hist. Crinoid. Actinocrinites, 30 dactylus*, Pl. 2.

Localities. Offham, Preston, Clayton*, and Brighton chalk-pits; the last mentioned locality was first discovered by Geo. Cumberland, Esq. of Bristol, to whose liberality I am indebted for the information.

ASTERIA, OR STAR-FISH.

But few remains of these animals have been discovered in Sussex, although they are not uncommon in the Kentish chalk.

30. The specimens in my possession consist of a few detached ossiculæ of *pentagonaster semilunatus*, (*Org. Rem.* Vol. iii. Tab. i. fig. 1,); and fragments of a species that appears to be distinct from any previously known.

FOSSIL ECHINI.

Of this order of mollusca, numerous species occur both in a recent and fossil state. They are marine animals, having a body more or less round, covered with a crustaceous shell, and furnished with moveable spines; the mouth being placed beneath. The crust or covering is composed of an immense number of plates, varying in form in different families, and in some species amounting to nearly a thousand in one individual. It has numerous perforations, through which the tentaculæ of the enclosed animal are protruded. These pores form bands (*ambulacra*) that divide the shell into segments (*areæ*), the latter being more or less covered with tubercles, to which the spines are attached by strong ligaments. Upon the death of the animal these ligaments undergo decomposition, and the spines almost constantly fall off, a circumstance that explains the cause of their being so seldom found in connexion with the shell, in a fossil state. The mouth is armed with five or six triangular teeth.

These animals feed upon crabs and the lesser kinds of shell-fish, which they seize and convey to their mouth by means of the tentaculæ, the spines being the instruments of motion*.

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* A specimen was discovered near Clayton, many years since, by Richard Weekes, Esq. of Hurstperpoint.

Various systematical arrangements of the echini have been formed by naturalists†; that of Leske, adopted by Mr. Parkinson, is followed in the subjoined description of the Sussex specimens.

Cidaris (the turban). This family comprises those echini which are of an hemispherical, globular, or oval form, with avenues of pores diverging equally on all sides from the vent to the mouth; vent vertical, mouth central.

31. Cidaris *saxatilis*. *Org. Rem.* Vol. iii. Pl. 3, fig. 1.

Hemispherical, depressed, with ten porous ambulacra, and two rows of small nearly equal tubercles, or papillæ, on each area.

This is a small species, seldom more than 0·7 inch in diameter.

Localities. Bridgwick, and South-street chalk-pits, near Lewes.

32. Cidaris *papillata*. *Org. Rem.* Vol. iii. Pl. 1, fig. 9.

Round, rather depressed, divided by undulating biporous ambulacra into five areæ, each having two rows of tubercles disposed alternately, and surmounted by perforated papillæ, encircled by a distinct groove at their base; the intermediate surface finely granulated.

This beautiful fossil is well known to collectors; it is rather rare in Sussex. It occurs occasionally in the upper chalk, and impressions of its plates and spines are sometimes observable on the flints and pebbles on the sea shore.

The spines of this species are slender, and delicately muricated; one of them is represented in Tab. xvii. fig. 13.

Localities. Upper chalk, near Lewes and Brighton.

33. Cidaris *Konigii*. *Org. Rem.* Vol. iii. Tab. i. fig. 10.

Circular, much depressed, divided by porous ambulacra into five large and five small areæ. The lesser divisions ornamented with two rows of tubercles, surmounted by imperforate papillæ, generally fifteen in each row; these are larger and more distant on the circumference or ambit of the shell, than on the vertex and base. The larger areæ have two sets of papillary tubercles, extending from the vertex to the base; and also two short rows that arise at the vertex, but do not reach below the circumference of the shell; hence there are thirty rows of tubercles on the vertex, and but twenty on the base. This remarkable character is seen in every specimen that has been submitted to my notice, and distinguishes the present species from Cidaris *mamillata*, with which it corresponds in every other respect. The ambulacra are quadriporous on the vertex, but become biporous on the circumference and base.

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* *Rees' Cyclopædia. Art. Echinus.*

† Mr. Konig has constructed an excellent arrangement of the fine suite of echini in the British Museum; and I much regret, that unavoidable circumstances have prevented me from adopting it on the present occasion.

I have named this elegant species in honour of Chas. Konig, Esq., of the British Museum.

Localities. Upper chalk, near Brighton and Lewes; casts occur in the flints of the South Downs.

34. Cidaris *corollaris*. Tab. xvii. fig. 2.

This name is applied by Mr. Parkinson to a siliceous nucleus, moulded in the cavity of a species of Cidaris *variola*. (Echino-cidaris of Konig). Specimens are not unfrequent among the flints on the ploughed lands of the South Downs.

CONULUS. (Echino-pileum of Konig). Conical, or oval, with porous ambulacra radiating from the summit to the base; mouth central, vent situate in some part of the base or margin.

35. Conulus *albogalerus*. Tab. xvii. figs. 8. 20.

Obscurely pentagonal, divided by ten biporous ambulacra, into five large, and five very small areæ; surface covered with minute granulæ. The vent placed on the margin; vertex with five perforations.

This species is very common in the Kentish chalk-pits, but is seldom found in Sussex.

Fig. 8, a lateral view; fig. 20, the base of the same specimen.

Localities. Upper chalk, near Lewes.

36. Conulus *albogalerus*, var. *acuta*. (Konig). Tab. xvii. figs. 16. 19.

In this variety the apex is acute, in other respects it differs but little from the preceding. The specimen figured is a siliceous cast, of which fig. 16 is a profile, and fig. 19, a sketch of the base.

Localities. Upper chalk, and ploughed lands near Lewes.

37. Conulus *vulgaris*. *Org. Rem.* Vol. iii. Pl. 2, fig. 3.

The siliceous nucleus figured by Mr. Parkinson under this name is from Sussex, but it appears to have been too imperfect to admit of its characters being accurately defined.

Locality. Upper chalk, near Lewes.

38. Conulus *subrotundus*. Tab. xvii. figs. 15. 18.

Subglobose, divided by biporous ambulacra into five wide and five narrow areæ; mouth small; vent placed in the margin.

This species is somewhat globular; the summit rounded, and rather depressed; the base flat; the mouth circular; the vent elliptical, and placed in the margin. The surface is studded with granulæ.

Figs. 15, 18, are different views of a siliceous cast collected near Mount Caburn, by my friend Thos. Woollgar, Esq.; the shell itself has but lately been discovered.

Localities. Upper chalk, near Lewes.

ECHINOCORYS (the helmet). Body vaulted, or helmet-shaped; base nearly flat; mouth and vent beneath, and opposite.

39. Echinocorys *scutatus*. *Org. Rem.* Vol. iii. Pl. 2, fig. 4.

Galeated, with a prominent ridge extending from the vertex to the vent; surface granulated, divided into five small, and five large areæ, by biporous ambulacra; base oval, with the vent placed near the margin of its longest diameter; mouth transversely reniform, situate at the broadest extremity, with a ridge passing from it to the base.

This species is found in great numbers in the vicinity of Lewes, and Brighton, and siliceous casts deprived of their calcareous covering, are very common among the flints of the Downs.

The cavity of the shell is generally filled with chalk, or flint, but in a few instances is partly hollow, and its inner surface lined with transparent crystals of carbonate of lime; these in all probability have been formed by an infiltration of calcareous spar through the substance of the shell, subsequently to the mineralization of the latter. One specimen in my collection is particularly interesting; the shell, as usual, is converted into spathose calcareous spar, and about one-fourth of its cavity is occupied by pure black flint, the surface of which, together with the sides of the shell, are incrusted with rhombic crystals of carbonate of lime*.

Localities. Upper chalk, throughout Sussex.

SPATANGUS. Body cordiform, or ovate; vent lateral.

40. Spatangus *cor anguinum*. *Org. Rem.* Vol. iii. Pl. 3, figs. 11, 12.

Cordiform, narrow extremity truncated, surface granulated; back convex, with five grooved quadriporous ambulacra, the two shorter ones extending obliquely towards the truncated extremity, and having a ridge between them, which passes to the vent; the two longer ones inclined towards the broader end; the fifth extending direct to the mouth, and forming a deep groove along the back. Mouth transversely reniform, its lower margin but slightly produced; vent placed in the upper part of the truncated extremity.

This species is too well known to require farther observation.

Localities. Abundant in the upper chalk throughout Sussex.

41. Spatangus *rostratus*. Tab. xvii. figs. 10. 17.

Cordiform, dorsal ridge rostrated; anterior part of the shell depressed.

This species resembles the preceding, but the ridge which extends from the vertex to the vent is strongly produced, while the opposite side of the shell is considerably depressed; these characters are so constant, that I have ventured to assume them as specific distinctions.

Localities. Chalk-pits, near Brighton.

42. Spatangus *planus*. Tab. xvii. figs. 9. 21.

Ovate, vertex rather depressed; surface nearly smooth, with eight (?) biporous ambulacra, diverging in pairs on each side the back and front; dorsal groove superficial, smooth, extending to the mouth; base slightly convex; mouth transversely reniform; vent placed in the upper part of the side.

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* Scilla (Tab. xix. fig. 3,) gives the representation of an *echino-cidaris*, partially filled with crystals " ripieni d'ingemamento bellissimo."

This species is a rare production of the chalk, and is distinguished by its ovate form, and by the ambulacra not being grooved as in the two former species. Its surface, in some instances, is covered with minute and indistinct papillæ, but generally appears perfectly smooth; even the ambulacra are scarcely perceptible. It is therefore possible, that a pair may extend to the dorsal groove, although none can be detected in that situation, in the specimens in my possession.

Figs. 9, 21, are different views of the same specimen.

A spatangus nearly related to this species, has very recently been discovered in the grey marl, at Hamsey; the summit is depressed, the base slightly concave, and the dorsal groove rather more distinct than in *S. planus.*

Locality. Lower chalk, near Lewes.

43. Spatangus ———. Tab. xvii. figs. 22, 23.

This species is perfectly smooth, and no traces of ambulacra are perceptible. The mouth and vent are placed as in the preceding species, of which, perhaps, the present specimen may be the shell in a young state.

Mr. Konig informs me they are not unlike Spatangus *prunella* of Lamarck, except that the ambulacra are not visible.

Figs. 22, 23, are sketches of the same individual. I have seen no larger examples.

Locality. Brighton; rather numerous in the Upper chalk.

ECHINITAL SPINES.

It has already been mentioned, that these are the instruments of motion, and are fixed by ligaments to the tubercles, or papillæ, of the crustaceous covering.

Specimens in which they are still attached to the shell, are very rare in a fossil state; the only example that has been discovered in Sussex, is in the possession of Miss Rebecca Godlee of Lewes; it is a Cidaris *papillata,* with four or five spines imbedded in the surrounding chalk.

The spines generally present considerable variety both in their forms and markings; but the following are the only species that have been observed in this district.

44. *Clavated* spines. Tab. xvii. figs. 11. 14.

These are delicately muricated; they belong to a species of Cidaris, to which Mr. Konig has applied the name of C. *claviger*.

Localities. Upper chalk, near Lewes, and Brighton.

45. *Cucumerine* spines. Tab. xvii. figs. 12, 13.

The elegant spine, fig. 12, is well known to collectors, and occurs in great perfection in the limestone of Calne, in Wiltshire; it belongs to Cidaris *sceptrifera* (of Konig). The other specimen, fig. 13, has previously been described as the spine of Cidaris *papillata**.

Locality. Upper chalk, near Lewes.

TESTACEÆ.

Univalves.

46. Cirrus *perspectivus*. Tab. xviii. figs. 12. 21.

Obtusely conical; volutions convex, transversely ovate, spirally striated; umbilicus deep, exposing one-third of the volutions; aperture transversely oblong.

The umbilicus of this species resembles in structure that of the celebrated staircase shell, (*Trochus perspectivus* of Linné,) exposing the inner edge of the volutions, to the extent of nearly one-third of their width. The volutions are six or seven in number, convex externally, smooth in the casts, but where portions of the shell remain, marked with fine spiral striæ.

The specimens are seldom more than chalky casts; vestiges of the shell itself being exceedingly rare. A few examples have, however, been noticed, in which the casts are covered with a nacreous pellicle, the remains of the internal pearly coat of the original.

Tab. xviii. fig. 12, represents the most perfect specimen in my possession; a portion of the original shell is attached to one of the volutions. This species sometimes attains two inches and a half in height, and four inches in diameter.

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* The teeth of echini have been discovered in the chalk, near Brighton, and I remember seeing several specimens, collected in the vicinity of that town, a few years since; but I have not been able to obtain a single example, either for description or representation.

—— Fig. 21. View of an interesting example of the base, exhibiting the structure of the umbilicus.

Localities. Upper, and Lower chalk of the South Downs; rare in the latter deposit.

47. Cirrus *depressus*. Tab. xviii. figs. 18. 22.

Spire depressed; volutions transversely ovate, spirally striated; aperture ——? umbilicus ——?

This shell might be referred to the genus *Euomphalus* of Sowerby, but is so clearly related to the preceding species, that I cannot hesitate to retain its present appropriation.

It differs from C. *perspectivus*, in the spire being scarcely elevated above the margin of the outer volution, the umbilicus must consequently be very shallow.

In a large specimen in my collection, the width of the base is 3·5 inches, while the height of the shell is 1·3 inch; some allowance, it is true, may be made for the effects of compression, but the circumstance is too constant to be the result of accident. The form of the aperture, and the structure of the umbilicus, are at present unknown.

Tab. xviii. fig. 18, represents the appearance of a specimen viewed from above.

—— Fig. 22. A perspective view of another example.

Locality. Upper chalk, near Lewes.

48. Cirrus *granulatus*.

Conical, volutions five or six, obscurely quadrangular, ornamented with regular, transverse, granulated striæ; umbilicus ———?

I have but very recently discovered this elegant shell, and only four imperfect casts are at present known: its characters are however sufficiently defined to identify the species. The volutions are depressed on the upper and under surface, and broad and slightly convex on the outer margin; the form of the inner edge is unknown. The striæ are about fifteen on each volution, very regular, and elegantly granulated, or moniliform; no traces of the shell remain.

Locality. Lower chalk, near Lewes.

49. Cast of a species of Dolium?

The fossil here alluded to, is the cast of a ventricose spiral univalve, consisting of three volutions. It is nearly seven inches long, and five in circumference. The body is ventricose, the surface smooth, the aperture oblong, extending the entire length of the last volution; the spire is very small, and depressed obliquely.

This specimen contains not the slightest remains of the shell, and is so much distorted, as to prevent the possibility of its generic characters being determined. In its general form, it bears some resemblance to the *Auricula* represented in Tab. xix. fig. 34; but is still more nearly related to the siliceous cast of a *Buccinum*, from St. Peter's mountain, figured by Faujus St. Fond. (*Hist. Nat. Mont. St. Pierre.* Pl. xxx. fig. 1. *a.*) It seems, however, more probable that the recent shell may have belonged to the genus *Dolium* of Lamarck.

Locality. Clayton chalk-pit. Collected by, and in the possession of, Richard Weekes, Esq. of Hurstperpoint.

50. Vermicularia *umbonata?*

Imperfect examples of a species related to V. umbonata, are sometimes found in the vicinity of Lewes. The spire is composed of three or four contiguous volutions, the outer one being produced in a curved form.

51. Vermicularia ——— ?

Masses composed of a smooth cylindrical shell, much convoluted or intertwined, are of frequent occurrence in the chalk, at Brighton; the propriety of placing them in the present genus cannot, however, be determined, till the discovery of more perfect specimens.

52. Serpula.

The remains of a species of serpula are very common on the shells of the *echini, inocerami,* &c.

53. Nautilus *elegans.* (vide *Grey Marl Fossils,* No. 27.)

Examples of this species, with the undulating markings but faintly expressed, are occasionally found in the chalk; perfectly smooth casts also occur, and these are probably referable to the same, the striæ being effaced by accident*.

Locality. Upper chalk, near Lewes.

54. Ammonites *varians.* (*Grey Marl Fossils,* No. 30.)† A few examples have been found in the Lower chalk, near Lewes.

55. Ammonites *Woollgari.* Tab. xxi. fig. 16. Tab. xxii. fig. 7.

Discoidal, depressed, volutions one-third inserted, transversely costated; costæ remote, slightly curved, inclined towards the aperture, terminating on the outer margin in compressed tubercles, or spinous projections; carene acute, deeply serrated.

The volutions are generally three or four in number, rather depressed, and ornamented with transverse ribs, that terminate on the outer margin in carinated tubercles, which are elongated into spinous projections in the adult shell (as in fig. 16. Tab. xxi.) In some examples, there are two tubercles on the outer extremity of each rib, and one on the inner margin. The carene is acute, and deeply serrated, the projections being almost angular.

This elegant ammonite is a rare production of the lower chalk: it varies in size from 0·5 inch, to four or five inches in diameter, and is easily identified by the serrated keel, and the form and disposition of the ribs, and tubercles.

I have named it in honour of my esteemed friend, Thomas Woollgar,

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* It is probable that the nautilus mentioned by Mr. Parkinson, (*Geolog. Trans.* vol. v. p. 56.) belongs to this species. It is stated to be nine inches long, six inches deep, and five wide; the whorls oblique, the back marked with small, closely set, transverse, undulating striæ; which agree in their direction with the contour of the shell.

The obliquity of the spire observable more or less, in almost every example of the chalk nautili, ammonites, &c. is clearly the effect of accidental compression, and has no relation whatever to the structure of the original.

† It may be remarked, that the upper chalk is the most recent formation, in which the shells of the genus ammonites have been discovered; the ocean which deposited it appearing to be the last abode of this tribe of testaceæ, no vestiges of their remains occurring in any of the superior deposits, and their recent analogue being unknown.

Esq. of Lewes; a gentleman, whose taste for science, leads him to patronize every attempt to elucidate the natural history, and topography, of his native town *.

Tab. xxi. fig. 16. A cast of the adult shell, with its spinous projections; a small specimen of Choanites *subrotundus* is attached to the inner volutions. It is scarcely necessary to observe, that the chalk ammonites, and other multilocular testaceæ, very rarely contain any remains of their shelly covering.

Tab. xxii. fig. 7. A cast of the young shell.

Locality. Lower chalk, near Lewes.

56. Ammonites *navicularis*. Tab. xxii. fig. 5.

Elliptical? umbilicate, volutions narrow, compressed, deeply inserted, rapidly enlarging; ambit convex, very broad, transversely costated; costæ numerous, smooth, rounded.

The specimen figured is the only known example of this species, and this is unfortunately imperfect; it is however remarkably characterized by its navicular form, the width of the ambit, large rounded costæ, and sudden increase of the outer volution. The ribs are perfectly smooth, and so numerous, as almost to expand into each other; with but few exceptions, they extend entirely across the ambit, forming a tuberculated margin on each side the wreaths. The form of the septa, aperture, and umbilicus, is unknown. The drawing is diminished to one-half the size of the original.

Locality. Upper chalk, Offham.

57. Ammonites *catinus*. Tab. xxii. fig. 10.

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* Since this was written, my lamented friend is no more; but I feel a melancholy pleasure in paying this humble tribute to his memory. For many years he had been ardently engaged in forming a collection of drawings, and manuscripts, illustrative of the topography of the south-eastern part of Sussex, with a view to publication; but a long, and painful illness, prevented the accomplishment of his wishes. To the future historian of Sussex, his labours cannot fail to afford material assistance; and his name will be associated by posterity, with those of Rowe, Burrell, Hay, Dallaway, and others, whose researches have lain the foundation of the history, of this former kingdom of the South Saxons. It is to be hoped that his son, John Webb Woollgar, Esq. M.A.S. whose scientific attainments are worthy of such a parent, will be induced to favor the public with the result of his father's investigations.

Depressed, volutions exposed, quadrangular; disk concave, expanded; ambit broad, oblique; a row of large obtuse tubercles on the outer margin.

The volutions are three in number, almost entirely exposed; their outer margin elevated, and crested with a row of large nodular projections. The ambit is broad, and smooth, inclined outwards, forming an obtuse angle with the inner surface of the volutions. The septa are numerous.

It is probable that this is the species described by Mr. Parkinson, as being "of a large size, with nodular projections on the sides towards the back, which is generally flat." (*Geolog. Trans.* Vol. i. p. 552.)

The specimen is nearly three and a half times the size of the figure.

Locality. Lower chalk, near Lewes.

58. Ammonites *rusticus.* *Min. Conch.* Tab. 177.

Depressed, volutions few, gibbous, exposed, with a row of conical tubercles on each side, and two rows on the back; aperture wider than long.

The whorls seldom exceed three in number. The bases of the larger tubercles almost touch each other, and expand nearly across the volutions. The back is broad, and rather flat; the tubercles upon it are numerous, and but little elevated. The inner side of the aperture is concave.

This species is of frequent occurrence in the lower chalk at Southerham, but the specimens are very imperfect. The fossil figured and described by Mr. Sowerby, is more distinct than any that have been found in Sussex.

This ammonite corresponds in some particulars with A. *catinus,* but is distinguished by the two dorsal rows of tubercles, and the gibbous form of the volutions.

Locality. Lower chalk, near Lewes.

59. Ammonites *Lewesiensis.* Tab. xxii. fig. 2.

Depressed, umbilicus minute; volutions wide, flat, almost entirely concealed; the external whorl equal to four-sevenths of the diameter of the shell; carene very narrow, rounded; aperture acutely sagittate.

This ammonite may be readily distinguished in a suite of specimens, although its characters are rather of a negative description. In its general form it resembles A. *complanatus*, (*Grey Marl Fossils*, No. 34;) but the umbilicus is larger, the carene less acute, and the surface exhibits no traces of striæ, or plicæ.

Its longest diameter is commonly about fourteen inches; width of the outer volution nine inches; greatest thickness five inches; at the external edge, one inch and a half. The volutions are but few, and with the exception of four or five obscure, transverse, radiating ridges, are perfectly even. The greatest thickness is at the inner margin, from whence the wreaths gradually taper to the keel. The outer volution increases rapidly, and is nearly equal to half the diameter of the shell.

In the specimen figured, which is nearly one foot and a half in diameter, the volutions appear to be wholly inserted, but probably in more perfect examples, their inner margin is exposed. The septa are sinuous, and very numerous; and the surface of the specimens is generally covered with thin, foliaceous impressions, which closely resemble those of the "ammonite articulée" figured by Faujus St. Fond, (Pl. xxxi. *Hist. Nat. St. Pierre.*)

Locality. Lower chalk, near Lewes.

60. Ammonites *peramplus.*

Discoidal, subumbilicate; volutions subcylindrical, nearly half inserted; a row of indistinct, distant, oblong eminences, on the inner margin; aperture transversely obovate.

This is a very large species, frequently exceeding two feet in diameter; it is seldom found entire. The longest diameter of a specimen in my possession is 24 inches; shortest diameter 18 inches; circumference of the outer volution, at the aperture, 23 inches; diameter of the umbilicus 7 inches; depth of the same 3·5 inches.

The volutions are four or five, almost half concealed, and in all probability, were originally cylindrical, but are now laterally compressed. The aperture has its inner edge indented by the preceding whorl. The back is smooth. The protuberances are indistinct, and wholly wanting in some examples.

This, and the species last described, are the largest ammonites of the chalk formation *; both are nearly destitute of ornament, yet their forms are so dissimilar, that even fragments can be distinguished with facility: those of A. *Lewesiensis* being flat, and thin, in proportion to their magnitude; while the remains of A. *peramplus* are convex, and almost cylindrical.

Localities. Upper chalk, near Lewes, and Eastbourne.

61. Belemnite ———. Tab. xvi. fig. 1.

This figure represents the only species of belemnite, that occurs in the Upper, and Lower chalk, of Sussex.

It is smooth, cylindrical, and unlike most of the genus, has no external sulcus. Longitudinal sections shew that a small tube extends from the alveolus to the apex of the spathose part.

Localities. Brighton, and Lewes.

62. Scaphites *striatus*. (*Grey Marl Fossils*, No. 35.)

This species has been discovered in the Lower chalk, at Brighton.

63. Hamites *alternatus*. (*Grey Marl Fossils*, No. 39.)

The existence of *Hamites*, in the Upper chalk, has not previously been noticed: two decided examples of the present species have been found near Lewes.

64. Pecten *quinquecostata*. Tab. xxvi. figs. 14, 19, 20.

Subtriangular, slightly oblique, longitudinally costated, transversely striated; lower valve gibbous, beaked, pentangular; upper valve flat, front pentarcuate, sides forming an acute angle; margin crenulated; ears small.

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* A fragment of A. *peramplus*, sent some years since to Mr. Sowerby, must have belonged to a specimen nearly three feet in diameter.

The length of this shell exceeds its width; it is slightly oblique, and the surface is covered by numerous diverging ribs, and furrows, decussated by fine transverse striæ: the lines of growth are deep, and frequent.

The lower valve is convex, beaked, and of a pentangular form; a large costa is placed on each angle, and four lesser ones on each of the intervening spaces. The beak is produced, and incurved. The upper valve is flat, rather depressed, and marked with diverging costæ, and sulci, corresponding in number with those of the lower valve. The hinge line is straight. The sides diverge from the beak towards the front, the margin of which is pentangular, and arcuate.

Tab. xxvi. fig. 20. A perfect specimen of both valves.

———— fig. 19. Inner surface of the upper valve.

———— fig. 14. A view of the back of the lower valve.

Localities. Upper, and Lower chalk, near Lewes, and Brighton; it also occurs in the ferruginous sand of Rackham common.

65. Pecten *nitida*. Tab. xxvi. figs. 4. 9. (1 ?)

Obovate, rather oblique, longitudinally striated; striæ numerous, radiating; upper valve flat; lower valve slightly convex.

A remarkably neat shell, much depressed, and rather oblique. The upper valve is perfectly flat; the lower one slightly convex. The striæ are prominent, and regular, radiating from the hinge line to the margin; about fifty on each valve. These are crossed by fine lines, which are scarcely visible to the naked eye. The margin is slightly crenulated, the ears are small, and placed obliquely; the lines of increase few, and indistinct; the length and width of the shell nearly equal.

Tab. xxvi. fig. 4, the inner surface of the lower valve; and fig. 9, the external surface of the flat valve; part of the lower shell is also seen, the upper valve being somewhat displaced.

———— fig. 1, represents the inner surface of a pecten, bearing considerable resemblance to the present species. Where portions of the shell have been removed, the impressions of the outer surface remaining upon the chalk, indicate the existence of striæ like those of P. *nitida*. The margin is however perfectly smooth, the hinge line straight, and the length of the shell exceeds its width, in a greater proportion than in the present species.

Localities. Upper chalk, near Lewes, and Brighton.

66. Pecten ———. Tab. xxv. fig. 14.

The specimen here figured, is in too mutilated a state to admit of specific distinction; but as a rare production of the chalk, it is worthy of notice. It is a thin, delicate, slightly convex shell, of a suborbicular form, marked with gentle undulating grooves, or furrows. The margin is entire, and smooth; no transverse striæ are perceptible, but the lines of increase are strongly marked. The figure is reduced one-third.

Locality. Upper chalk, near Lewes.

67. Pecten ———. Tab. xxv. fig. 6.

The cast of a small pecten, its surface marked with eleven radiating costæ;—the imperfect state of this fossil prevents the determination of its species.

Locality. Upper chalk, near Lewes.

68. Plagiostoma *spinosa.* Tab. xxvi. fig. 10.

Obovate, inequivalve, longitudinally furrowed; the flatter valve armed with spines: sides nearly equal; beaks incurved, approximate; ears small, even; margin denticulated.

This fossil is remarkably distinguished from the other shells of the chalk, by the long slender spines attached to the upper valve.

Each valve has from 25 to 30 rounded costæ, formed by intervening furrows, that radiate from the beaks to the margin; these are decussated by fine transverse striæ, and the lines of increase; the inner surface of the shell is also marked with corresponding impressions. The lower valve is most convex, and has the line of the hinge straight; the upper valve is spinous, rather depressed, and contains the angular sinus, by which the shells of this genus are characterized.

The spines arise from the ribs, but without any regularity, except that they are more numerous at the sides, than in the centre. They vary from 15 to 20 in number, and are from half an inch, to two inches and a half in length; each spine has a groove on the under, and a corresponding ridge on the upper surface. They generally project from the shell, but in some instances lie close on the surface.

The beaks are convex, and incurved; the ears small, and even; the margin neatly denticulated. A specimen cleared from the chalk, exhibited no muscular impression.

There are several varieties of this species, of which the following are the most remarkable:

Var. a. With both valves gibbous, and but few spines.

b. Valves depressed, spines numerous.

c. Valves gibbous, ribs regularly convex and even.

d. ————, ribs channelled near the front.

This shell is one of the most common productions of the Upper chalk, but is less frequent in the lower beds; the hardness of the Sussex chalk renders it exceedingly difficult to clear the specimens, without destroying the spines.

Localities. The chalk-quarries in every part of the South Downs. Siliceous casts of the interior of the shell, occur among the flints on Plumpton Plain.

69. Plagiostoma *Brightoniensis.* Tab. xxv. fig. 15.

Obovate, depressed, longitudinally costated: posterior side eared; anterior side lunulate, concave, small, acuminated; margin crenulated.

The length of this species is 3 inches; greatest width 2·5 inches; thickness of the united valves, 1 inch: the convexity of the valves is nearly equal. The costæ are somewhat flattened, and channelled towards the anterior margin; there are about thirty on each valve. The anterior depression is elongated, and marked with longitudinal striæ; the posterior side is short, and eared. The lines of growth are very distinct.

Locality. The specimen figured is from the Upper chalk of Brighton.

70. Plagiostoma *Hoperi.* Tab. xxvi. figs. 2, 3, 15.

Transversely ovate, oblique; valves convex, covered with numerous diverging striæ; posterior slope short; anterior slope concave, elongated, obliquely striated; ears unequal; margin entire.

This shell is nearly related to *P. rigida*, and *P. ovalis* of Sowerby, (*Min. Conch.* Vol. ii. tab. 114) from which it is distinguished by the inequality of the ears, and the deep elongated lunette of the anterior side. The general form of the shell is also somewhat dissimilar, and the striæ are less distinct than in the fossils above mentioned.

This species presents considerable variety both in its form, and markings, but the differences observable, are not sufficiently constant to require notice. It is more or less obliquely oval, but forms a larger segment of a circle, than is strictly implied by that term. The length and width nearly correspond; and the thickness of the united valves equals about half the length. The striæ, or rather sulci, are undulated, and distinct, in some examples, but in others are altogether wanting. The lunette, or depression on the anterior side, is very deep, and extends from the beaks to the commencement of the front; it is marked by numerous oblique striæ, which are decussated by the lines of growth. The ears are plicated; that on the anterior side is small, and obscure, but the other is distinct. The beaks are small, and terminal.

I have named this elegant shell in honour of the Rev. Henry Hoper, A.M. of Portslade, to whose kindness I am more indebted, than his modesty will permit me to acknowledge.

Tab. xxvi. fig. 2. A specimen of the depressed variety with but few striæ.

——— fig. 3. A shell in which the striæ are distinct.

——— fig. 15. The united valves, the upper one rather displaced; this example exhibits the lunette on the anterior side.

Localities. Upper, and Lower chalk, near Lewes.

71. Dianchora *lata*. Tab. xxvi. fig. 21.

Semicircular; beak prominent; free valve plain.

The obliquity of this species is scarcely observable. The "lines of growth being slightly marked, and the gentle convexity of its form, added to the indistinctness of the few striæ upon its surface, and the sharpness of its margin, give it a peculiar neatness *." The specimen figured and described by Mr. Sowerby, was found in the chalk near Lewes. I have not been so fortunate as to discover another example of the united valves.

Tab. xxvi. fig. 21, represents the inner surface of a mutilated specimen of the lower valve.

Locality. Upper chalk, near Lewes.

72. Dianchora *obliqua*. Tab. xxv. fig. 1. Tab. xxvi. fig. 12.

Obliquely obovate; upper valve convex, marked with numerous diverging striæ; margin serrated.

The free valve is convex, and marked with upwards of 50 prominent striæ, separated from each other by fine sulci, and terminating in an acutely serrated margin. The beak is acuminated; the ears small, and unequal. The lower valve, by which it is attached to other bodies, has its inferior surface finely granulated; its sides are erect, wide at the anterior and posterior slopes, but very narrow in front. The posterior side is more elevated than the anterior, and the upper valve is in consequence inclined obliquely.

This species is distinguished from *D. lata* by its ovate form, and numerous striæ; and from *D. striata*, (the only other known species) by its obliquity, striated surface, and denticulated margin.

Tab. xxv. fig. 1. is a perfect specimen; it shews the triangular cavity beneath the beak, formed by the union of the valves; the smooth, erect border of the lower, and the striated surface of the upper valve.

Tab. xxvi. fig. 12. The upper, or convex valve, detached; collected by Col. Birch.

Localities. Upper chalk, near Lewes, and Brighton.

73. Ostrea ———. *Smith's strata*, Upper chalk. Figs. 5, 6.

The shells of the genus ostrea are so irregular in form, and the same species, in different stages of its growth, exhibits such dissimilar appearances, that it is very difficult to arrange them with precision. This consideration has induced me to relinquish the attempt to distinguish those that occur in Sussex by specific names; since the specimens present no remarkable character, and although of various shapes, and degrees of convexity, are probably only varieties of one species.

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* *Min. Conch.* Vol. i. p. 184.

The shells figured by Mr. Smith, are of frequent occurrence in the Upper chalk, near Lewes, and are commonly attached to other bodies; they appear to be the upper and under valves, of the same species. They are nearly flat, of a suborbicular form, their margins very thin, and much expanded.

74. Ostrea ———. Tab. xxv. fig. 4.

This shell is rather depressed, of an oblique, ovate form, the external surface scabrous, the margin thin, and undulated by five or six depressions. The hinge is tripartite, marked with transverse plicæ, and the adjoining edge of the shell on each side, has a row of crenulated indentations; the inner border of the hinge is straight, and rendered very distinct by a deep hollow that extends beneath it. The inner surface is marked with a few gentle concentric ridges. The muscular impression is slight.

Three or four examples have been discovered with the characters above enumerated very distinctly marked, while others occur in which they are but obscurely expressed; it is not improbable, that in a suite of specimens, the present variety may pass insensibly into the flat oyster, previously noticed.

Locality. Upper chalk, near Lewes.

75. Teredo ———. Tab. xviii. fig. 23.

The Teredo *navalis*, or ship-worm, is well known for its depredations on the hulls of vessels, which in warm climates, it sometimes completely destroys. The fossil, like the recent species, is found inhabiting cavities which it has formed in blocks of wood; and the wood, with the shells imbedded, is frequently discovered in a petrified state, in many parts of England*.

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* Specimens of this kind are figured by Parkinson, *Org. Rem.* Vol. i. Pl. viii. fig. 9. They are very abundant in the London clay; some of the finest examples known were collected by the author on the banks of the Regent's Canal.

Portions of the tubular part of the shell, are the only vestiges that occur in the Sussex chalk; these are sometimes enclosed in fragments of carbonized wood, but owing to the friable nature of the latter, are more commonly found detached. The specimens are of a depressed, cylindrical form, more or less bent, and gradually tapering to a point. Their diameter at the larger extremity, seldom exceeds half an inch; their length varying from one to six inches. The surface is smooth, and has numerous, indistinct, annular elevations, and depressions, like the recent teredo; of which, in fact, the present species appears to be only a variety.

Tab. xviii. fig. 23, represents the usual appearance of these fossils.

Localities. Upper chalk, near Lewes, and Brighton.

76. Terebratula *subrotunda*. *Min. Conch.* Tab. xv. figs. 1, 2.

Circular, depressed, smooth; valves regular, equally convex; beak short.

The width of this shell rather exceeds its length, which is seldom more than 0·7 inch. The sides, near the beak, are somewhat angular. The surface of the valves is smooth, and marked by fine, transverse lines of growth.

The lower, or beaked valve, has two hinge teeth, and the upper valve, two corresponding grooves for their reception, from which two elongated appendages proceed. This structure is beautifully represented by Mr. Sowerby, in fig. 6. Tab. xv.

Localities. Common in every part of the South Downs.

77. Terebratula *ovata*. *Min. Conch.* Tab. xv. fig. 3.

Obovate, depressed, smooth; upper valve depressed.

In this species the proportions are reversed; the length exceeding the width. It is nearly of the same size as the former; the beak is rather more produced.

Localities. Upper, and Lower chalk, near Brighton, and Lewes.

78. Terebratula *undata*. *Min. Conch.* Tab. xv. fig. 7.

Obovate, both valves convex, smooth; front margin straight, with a deep undulation on each side; beak produced.

The length of this species exceeds its width. It is distinguished from the two former, by the straightness of the front, and the deep undulations on each side. The beak is produced, and its perforation large; both valves are equally gibbous. It sometimes attains 1·5 inch in length.

Localities. Common in every quarry in the South Downs.

The three species above described are easily distinguished from each other; but it must be confessed, that the two following are so nearly related to the preceding, and in a suite of specimens pass so insensibly into each other, that the propriety of their separation may be questioned. I have, however, followed the arrangement of Mr. Sowerby, to avoid a multiplication of synonymes[*].

79. Terebratula *intermedia*. *Min. Conch.* Tab. xv. fig. 8.

" Obscurely five sided, rather depressed, smooth; larger valve most convex; front margin undulated; three depressions in the smaller valve, and two in the larger."

The undulations in this species are not confined to the margin, but extend some distance along the body of the valves; the front is depressed.

Localities. Upper, and Lower chalk, South Downs.

80. Terebratula *semiglobosa*. *Min. Conch.* Tab. xv. fig. 9.

"Nearly circular, gibbous, smooth; larger valve deepest, and uniformly gibbous; front margin undulated, with two ridges on the lesser valve."

The width of this shell nearly equals its length; some specimens are very gibbous. The undulation in front, the two eminences on the upper valve, and the width and thickness of the united valves, appear to be the distinguishing characters of the species.

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[*] A friend who has paid some attention to the subject, has favoured me with the following arrangement of these shells.

Terebratula *undata*. *Min. Conch.* Tab. xv. figs. 7, 8, 9.

Spec. char. Obovate, both valves convex, smooth; margin of the front either straight or depressed, undulated on each side; beak produced.

Var. *a. subundata*, (fig. 7.) Longer than wide, front *straight*; valves equally convex.

Var. *b. intermedia* (fig. 8.) Rather depressed, longer than wide; larger valve most convex; front *undulated*; undulations extending upon the valves.

Var. *c. semiglobosa* (fig. 9.) Subglobose; length, width, and thickness nearly equal; front margin undulated.

The above descriptions refer to those specimens which present the most striking differences; it would be easy to select examples of every intermediate gradation of form.

The shells of the terebratulæ above described, are invariably changed into crystallized carbonate of lime; their cavities, like those of the echinites, being frequently lined with calcareous spar, or crystals of sulphuret of iron. Their prevailing hue is a deep cream colour, but sometimes shades of red, brown, and blue, are observable; may not this in some measure depend on the colour of the original?

Localities. Upper, and Lower chalk, South Downs.

81. Terebratula *plicatilis*. *Min. Conch.* Tab. cxviii. fig. 1.

——————— var. *b. octoplicata*. *Min. Conch.* Tab. cxviii. fig. 2.

——————— var. *c. concinna*. *Min. Conch.* Tab. lxxxiii. fig. 6.

Gibbous, transversely obovate, longitudinally striated: margin finely serrated; front sinuate, elevated with from six to twelve acute plicæ; beak slightly projecting.

The difference in the number of folds on the front, is assumed by Mr. Sowerby, as the specific distinction between his T. *plicatilis*, and T. *octoplicata;* T. *concinna* is separated on account of its more globose form. The specimens in my possession vary so much in the number of plicæ, and in the convexity of the valves; and the characters of each are so intimately blended in many examples, that I have been compelled to consider them as only varieties of the same species.

In var. *a.* the length of the shell exceeds the depth of the united valves, and the width is one-third greater than the length; the front margin is elevated by a broad sinus containing twelve plicæ. Var. *b.* has but eight plicæ. In var. *c.* there are but seven plicæ; the valves are globose, the depth and width of the shell being nearly equal.

The striæ are rounded, and diverge with a gentle sweep from the beaks to the margin; the number on each valve varying from thirty to fifty. The lower valve is less convex than the upper; the beak is but slightly produced, and the perforation very small. The lateral margin is acutely serrated, and sometimes marked by several rows of plicated indentations, formed by the lines of growth.

The elevated front margin, and the numerous striæ with which both valves are covered, distinguish the present species from the other striated terebratulæ of the chalk.

Localities. Upper, and Lower chalk, near Brighton and Lewes.

82. Terebratula *subplicata*. Tab. xxvi. figs. 5, 6, 11.

Transversely ovate, gibbous, nearly smooth; lower valve depressed, upper valve convex; margin serrated; front sinuate, with three or four sharp plicæ; beak slightly produced.

This is a small species, well characterized by its smooth surface, and elevated plicated front. The young of T. *plicatilis*, (the only chalk terebratula with which it can be confounded) have both valves covered with minute striæ.

Like the other species of this genus, considerable variety is observable in the contour of the shell, in different specimens. The plicæ are from three to five in number, and extend a short distance on both valves. The beak is very small.

Locality. Upper chalk, near Lewes.

INOCERAMUS.

This genus was formed by Mr. Sowerby for the reception of the fibrous bivalves, whose fragments occur in such prodigious quantities, in almost every locality of the Upper and Lower chalk. These shells were first noticed by Da Costa, who describes them as being " very large limpets, which, like the concholepas, resemble the single shell of a bivalve. They are of two kinds, and more irregular than that shell; and instead of being sulcated lengthwise, are circularly wrought, in a transverse manner, with very high irregular ridges, not thickly but rather thinly set. The shells are very thick; one sort is high and copped; the other is broad and flattish* "

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* *Elements of Conchology*, p. 142.

In the third vol. of Mr. Parkinson's "*Organic Remains*," a fragment of an inoceramus is accurately represented, (Pl. v. fig. 3), and is noticed by that author as "part of an uncommon fossil shell, resembling a patella in some of its characters[*]."

The celebrated geologists, M. M. Cuvier and Brongniart, were induced from the striated crystalline structure of the shells in question, to regard them as belonging to the genus Pinna; but fragments of the hinge having been subsequently presented to their examination, they were led to doubt the correctness of their former opinion[†].

For a knowledge of the structure of these curious shells, we are indebted to the acumen and zeal of Miss Benett, of Norton House. From specimens in her cabinet, and with the assistance of others collected by the present writer, Mr. Sowerby has constructed the following generic definition.

INOCERAMUS.

A free, inequilateral, beaked bivalve; hinge linear, channelled, transversely sulcated, extending on one side of the beaks only; cartilage partly external; no visible muscular impression?

The shells of this genus are more or less gibbous, and are commonly marked with transverse concentric ridges, and striæ; their constituent substance is invariably composed of crystallized carbonate of lime, of a radiated or fibrous structure.

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[*] *Organic Remains*, Vol. iii. p. 51.

[†] "Il n'est pas sûr que les gros fragmens planes, de 12 millemètres d'epaisseur, et à texture striée qu'on trouve dans la craie, appartient à ce genre de coquille. Nous avons vu chez M. Defrance, des portion de charnière qui indiquent un autre genre." *Géograph. Min. des Environs de Paris.* p. 11.

Perfect specimens of this fragile tribe of shells are so exceedingly rare, that even at the present time, the distinguished naturalists above mentioned, have not been able to obtain an example, in which the structure of the hinge is satisfactorily shewn.

In a recent communication from M. Brongniart, that gentleman remarks, "Je suis extremement embarassé pour déterminer la coquille fibreuse si commune dans la craie, et dont vous avez représente diverses parties dans votre Planche xxvii. J'ai voulu aussi faire figurer cette coquille, mais n'ayant pas eu le bonheur d'en avoir des échantillons assez entiers, j'ai été forcé de me contentir de fragments, et de donner la copie de votre figure 1, Pl. xxvii."

The hinge is a longitudinal furrow, transversely crenulated, extending on one side of the beaks only; its direction, as it regards the transverse diameter of the shell, being generally oblique.

There are several species, and many varieties, and in some specimens the characters are so much blended as to be distinguished with difficulty. The shell represented in fig. 1, Tab. xxvii. is an excellent type of the genus, and is probably the most perfect specimen hitherto discovered.

83. Inoceramus *Cuvieri.* Tab. xxvii. fig. 4. Tab. xxviii. figs. 1. 4.

Convex, with large, obtuse, distant, transverse costæ; surface covered with numerous linear lamellæ; hinge side depressed, expanded; posterior side flat, nearly smooth; beaks small, reflexed; hinge oblique.

The number of the costæ varies from eight to twelve; they are large and rounded, and extend with a gentle sweep across the valves, being gradually lost in the expanded anterior side. The surface is covered with transverse lines, and possesses a lamellated structure, appearing as if composed of a succession of thin plates; but the substance of the shell is perfectly solid, and consists of fibrous calcareous spar. The posterior side is nearly flat, and smooth; the hinge is placed obliquely. The comparative width and length of this species cannot be determined, since no perfect specimen has been discovered.

The adult shell attains a gigantic size; a specimen in my possession must, when entire, have exceeded three feet in length, and twenty inches in width. Fragments of the hinge of a corresponding magnitude are not uncommon, some of them being more than 1·5 inch wide, and 1·2 inch thick.

This species is named in honour of the illustrious Cuvier, to whose researches the comparative anatomist, and the geologist, are so greatly indebted.

Tab. xxvii. fig. 4, fragment of the hinge, exhibiting the transverse crenulated sulci.

Tab. xxviii. fig. 1, a specimen, the interior of which is filled with flint.

——— fig. 4, represents the upper and lower valve of the same individual imbedded in a block of chalk: the hinge groove is placed beneath the oblique line on the left side of the uppermost valve.

Localities. Common in the Upper chalk, near Lewes, Eastbourne, &c.

84. Inoceramus *Lamarckii*. Tab. xxvii. fig. 1.

Valves equal, very convex, with a few obscure, longitudinal undulations, and distant transverse ridges; surface covered with numerous concentric striæ; posterior slope subdepressed; anterior side lobate, expanded; hinge nearly transverse.

Both valves are equally convex, and gradually expand towards the margin; the greatest convexity being near the middle of the shell, which is suddenly contracted longitudinally, and has a lobated appearance on the hinge side. The beaks are incurved and inclined toward the posterior slope, which is slightly concave. The anterior side is convex, expanded, and separated from the body of the valve by a deep furrow or depression. The hinge is nearly transverse. The whole surface is marked with fine transverse striæ, disposed concentrically on the convex part, and expanding over the anterior side with an elegant sweep, terminate on the hinge line. The ridges are distant, and vary in strength and number, but seldom exceed six or eight on each valve. The longitudinal depressions mentioned by Mr. Parkinson as affording a specific distinction, are obscure in many instances, and altogether wanting in others. The specimens are from 3 to 4 inches long, and 2·5 inches wide; the greatest convexity of the united valves is 3·5 inches.

Mr. Parkinson, "as a tribute of gratitude for the advantages afforded to science by the classification of Lamarck, has affixed his name to the present species*."

Localities. Upper chalk, near Lewes, and Brighton.

85. Inoceramus *Brongniarti*. Tab. xxvii. fig. 8.

Equivalved, gibbous, transversely costated; anterior side angular, acute; posterior side flat, truncated; hinge transverse, straight.

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* *Geological Transactions*, Vol. v. p. 55.

This shell is very gibbous, the convexity of the united valves being equal to its length. The valves are regular, and gradually increase in width from the hinge to the front; there are about twenty prominent ridges, or costæ, on each, which diverge from the posterior slope over the convexity of the shell, and terminate with a gentle curve on the border of the hinge. The posterior side is flat, the anterior acute, forming an angle with the hinge; the latter is transverse, its plane corresponding with the transverse diameter of the valves. The front is rounded, the margin very entire; the beaks small and reflexed.

The present species may be distinguished from the preceding by the number and strength of the costæ; the flat, truncated, posterior slope; and more particularly, by the hinge side, which is not expanded as in I. *Lamarckii.*

I have named this elegant shell in honour of my friend M. Brongniart, the able colleague of Baron Cuvier, author of "*Géographie Minéralogique des Environs de Paris*," &c.

Tab. xxvii. fig. 8, an excellent specimen in which the characters of the species are well defined; the beaks are broken off. This figure is reduced to one-half the size of the original.

Tab. xxviii. fig. 3, an imperfect example of a variety of this species.

Localities. Upper chalk, near Lewes, and Brighton.

86. Inoceramus *mytilloides.* Tab. xxviii. fig. 2.

Depressed, elongated, with numerous concentric striæ, and a few distant ridges; posterior slope inflated, its margin plicated; anterior side depressed, expanded; beaks acuminated; hinge very oblique.

The shell is most convex near the beaks, and gradually becomes flatter and more expanded towards the margin. The beaks are produced, and terminate in a sharp point, over the commencement of the hinge; the plane of the latter is placed at an acute angle with the longitudinal diameter of the valve.

The striæ are numerous, and form a few irregular ridges that terminate in folds, on the margin of the posterior slope. Fragments of this species are not uncommon in the Lower chalk of Sussex; but I have not seen a perfect specimen.

Tab. xxviii. fig. 2. A specimen from Plumpton.

The shell represented in Tab. xxvii. fig. 3. has the acuminated beaks, and oblique hinge of the present species; but the ribs are more prominent and numerous, and the valves more convex: it may, perhaps, hereafter prove to be specifically distinct.

Localities. Plumpton, Offham, Southerham.

87. Inoceramus *latus*. Tab. xxvii. fig. 10.

Valves convex near the beaks, flat and expanded towards the front; surface marked with distant transverse ridges, and numerous concentric striæ; posterior slope smooth, depressed? anterior side expanded; hinge oblique.

This species equals I. *Cuvieri* in length and width, but is much depressed, and is also destitute of the prominent costæ by which that species is distinguished; fragments occur that are from eighteen to twenty inches wide, and almost flat. The posterior side is smooth, and depressed? the anterior expanded; when this part is broken off, the valves assume a triangular form, as in the example figured. The hinge is very oblique.

Tab. xxviii. fig. 10, exhibits the usual appearance of the specimens: the figure is diminished three-fourths.

Localities. Common in the Upper chalk near Brighton, Lewes, Offham, &c.

88. Inoceramus *Websteri*. Tab. xxvii. fig. 2.

Convex, smooth, with distant, irregular, transverse ridges; beaks rounded, posterior slope nearly flat; anterior side expanded, hinge very oblique.

The valves are convex, the surface smooth, and the ridges placed at unequal distances. The greatest convexity is near the beaks, from whence the shell gradually becomes flatter, and expands as it approaches the front. The posterior slope is small, and somewhat depressed, the hinge side flat, and broad.

This species differs from I. *Brongniarti*, in the ridges being distant, and irregular; and from the young of I. *Lamarckii*, in the greatest convexity being near the beaks, and not in the centre of the valves, as in that species. It is a small shell, seldom exceeding the size of the figure, and is named in commemoration of the interesting researches of Thomas Webster, Esq. keeper of the Museum of the Geological Society, whose unassuming manners, and extensive information, have obtained him the respect, and esteem, of all who have the pleasure of his acquaintance.

Locality. Lower chalk, South-street: very rare.

89. Inoceramus *striatus*. Tab. xxvii. fig. 5.

Gibbous, rounded, even, with numerous transverse striæ; hinge oblique? beaks ——— ?

The roundness of this shell, and its finely striated surface, readily distinguish it. The specimen figured, has a ridge down the convex part of the valve; but as this appearance is not constant, it is omitted in the specific description. A perfect example has not been discovered.

Locality. Lower chalk, South-street: very rare. It occurs also in the chalk near Heytesbury, Wilts.

90. Inoceramus *undulatus*. Tab. xxvii. fig. 6.

Convex, marked with numerous, regular, transverse elevations, and depressions; posterior slope truncated; hinge side expanded.

The surface being gently undulated by the round, even, alternate elevations, and depressions, this shell has a peculiarly neat appearance. The posterior slope is flat, and nearly smooth. The valves are regularly convex, but hollowed or contracted on the anterior side, which is expanded. The beaks are rounded, and incurved.

Locality. Upper chalk, near Lewes.

91. Inoceramus ———. Tab. xxvii. fig. 9.

This shell is rather depressed near the beaks, and inflected in front; it has numerous concentric ridges and striæ. It is in too mutilated a state to admit of a more particular description.

Locality. Lower chalk, Lewes.

Fragments of other species of Inoceramus occur in the chalk in the vicinity of Lewes, but the specimens hitherto collected, are not sufficiently perfect to warrant their specification.

92. Parasitical bodies in the shells of various species of Inoceramus. Tab. xxvii. fig. 7.

The shells of the larger Inocerami appear to have been subject to the ravages of a peculiar parasitical animal, which destroyed the intermediate substance, leaving the outer and inner plates entire, and supported only by thin partitions. The specimens exhibiting these appearances, are full of small oblong cells, connected by linear perforations; and these are either empty, or filled with chalk, or flint; in the latter case, they give rise to a curious class of fossils, the nature of which has but very lately been explained.

A specimen of this kind is represented Tab. xxvii. fig. 7; it is part of a flint, moulded in the interior of an Inoceramus, containing on its surface, numerous irregular oblong bodies, more or less compressed, and united to each other by slender lateral filaments.

These curious bodies were first noticed by Mr. Parkinson *; and have subsequently formed the subject of an interesting memoir from the pen of the Rev. W. Conybeare, published in the 2d vol. of the Geological Transactions.

The investigations of Mr. Conybeare, have clearly elucidated the origin of the fossils in question, and shewn "that they are siliceous casts, formed in little cells, excavated in the substance of certain marine shells, the work of animalculæ preying on those shells, and on the vermes inhabiting them. These casts, like the screw-stones of Derbyshire, must have been formed by the infiltration of siliceous matter while in a fluid state into the cavities of the shells, and which have been laid open and denuded by subsequent exposure to some agent, capable of dissolving and removing the calcareous matter of the shell forming the matrix, while the siliceous cast remained unaltered †."

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* *Organic Remains*, Vol. ii. pp. 75, 76.

† *Geological Transactions*, Vol. ii. p. 328.

In a very interesting fossil in my possession (from St. Peter's mountain, near Maestricht,) changes of a similar nature have taken place, but with this difference, that the

Upon this subject, Professor Buckland remarks, "that the hollows affording a mould for the formation of these bodies, are clearly the work of some minute parasitical insect. The small aperture, the cast of which now forms the projecting axis of each globule, was probably perforated by this intruder, as the entrance to his future habitation. Having completed this passage, and excavated at its termination a cell suited to his shape and convenience, he appears by the aid of a delicate augur or proboscis, to have drilled many minute and almost capillary perforations into the substance of the shell on every side around him; taking care to leave always partitions sufficient to support the thin external plate of the shell which formed the roof of his apartment. Having exhausted all the nourishment that could be procured in this manner with safety from the vicinity of his first establishment, the insect appears to have emigrated, and after working for itself a lateral passage to a considerable distance, to have formed a new settlement in the midst of fresh supplies. In a recent oyster shell in my possession, this process has been carried on to a great extent in the intermediate matter between two or three sets of the pearly plates comprising it; and yet without effecting the destruction

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casts, and their surrounding matrix, are composed of limestone, of a subcrystalline structure. The specimen contains numerous casts and impressions of bivalve shells, univalves, madreporites, &c.; the forms of which are defined with much sharpness, and elegance. The cavities left by the removal of the shells, are more or less filled with groups of globular bodies, and are crossed by slender filaments, evidently moulded in perforations that existed in the recent testaceæ.

As the constituent substance both of the shells, and casts, in the present fossil, were originally composed of nearly similar materials, it appears difficult to explain by what agency the one has been removed, while the other has remained uninjured. The following observations of Mr. Parkinson, will illustrate the mode by which this operation has been effected.

"Calcareous spar, exposed to the action of water, suffers through a long period but little change or diminution; while on the other hand, animal substances, such as shells, the crustaceous parts of animals, and other bodies formed of an intermixture of animal membrane or gelatin, with carbonate of lime, undergo a very rapid decomposition by the agency of water alone, as is the case with dead shells, &c. on the sea and river shores. In these instances, the animal membrane suffers resolution particle after particle, and layer after layer, and the carbonate of lime deprived of its cement and support, gradually separates and moulders away *." Thus it has happened to the shells enveloped in the crystalline limestone before us; while the animal substances have been decomposed by the action of simple water, the investing matrix has suffered no change, but perfectly retains the form and impressions of the animal bodies that have passed away.

[*] *Org. Rem.* Vol. ii. p. 173.

of the exterior crust, or in any degree injuring the inner surface of the shell, which remains untouched; and notwithstanding these attacks, still equally adapted to every purpose required by the economy of its inhabitant*."

Siliceous specimens of this fossil are not frequent in Sussex; but there are scarcely any of the larger Inocerami that do not exhibit traces of the depredation of this parasite, the cells being either empty, or filled with chalk.

The example figured in Tab. xxvii. was found on the beach, at Brighton; the shell is entirely removed.

93. Balanus. Tab. xxxiii. fig. 11.

The specimen figured, is the only vestige of a multivalve shell that has been noticed in the chalk of Sussex.

It is gently curved, has two sharp ridges, and not inaptly resembles the beak of a bird; it is the valve of an operculum of some unknown species of Balanus.

Locality. Upper chalk, near Lewes.

Crustacea.

The fossil remains of those species of cancer, in which the crustaceous covering is hard and compact, are not unfrequent in the London clay at Highgate, Sheppey, &c.; and a few have already been noticed as occurring in the Blue chalk marl of Sussex: but the lobster, cray-fish, and other species, whose structure is more delicate and fragile, are but seldom found in a mineralized state, and rank among the most rare and interesting objects in the cabinet of the oryctologist.

About seven years since, the remains of an unknown crustaceous animal were discovered in the Upper chalk near Lewes; but the mutilated and brittle state of the specimens defied all my attempts to ascertain their original form. In the hope, however, that from detached portions of the animal, the required information might ultimately be obtained, every fragment that could be procured was carefully examined and preserved, and the result has ultimately exceeded my most sanguine expectations, since not only the generic, but also the specific characters of the original have been determined.

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* Oyster shells perforated in the manner here described, are frequently found on the seashore at Hastings.

The remains in question are composed of a delicate friable crust, and when first collected are of a dark chocolate colour, inclining to black, but become pale, and lose much of their beauty by exposure to the air. The inner surface only, is seen in those specimens that are exposed by fracture; it is glossy, and covered with minute circular depressions, formed by the bases of the spines. The external surface is armed with short spines, and papillæ, and is invariably concealed by the chalk, until the latter be carefully removed by art; a process, which from the delicacy of the fossil, and the hardness of the surrounding matrix, is exceedingly difficult and tedious, and can scarcely be accomplished by an inexperienced hand. Of the specimens in my collection, some contain the claws, others the thorax, and a few exhibit the abdomen, and tail. These detached parts having been accurately delineated, a restored outline of the original was formed, and by a careful comparison of the latter with the recent crustacea, the genus and species of the original have been ascertained.

94. Astacus *Leachii.* Tab. xxix. figs. 1, 4, 5. Tab. xxx. figs. 1, 2. Tab. xxxi.

Gen. Char. Antennæ pedunculated, unequal; the exterior ones long and setaceous; inner pair divided at the extremity; body elongated; legs commonly ten; tail foliaceous.

Spec. Char. Thorax scabrous, convex, sixlobed, marginate; head semicircular in front; hands chelate, muricated, twice the length of the thorax; pincers very long, armed with obtuse spines.

The thorax is longitudinally oblong, convex, covered with small tubercles and papillæ; it is divided into six lobes by a rounded dorsal ridge, and two lateral sulci; the margin is entire.

The form of the head of this species is unknown; it appears to have been semicircular or rounded in front, and is not distinct from the thorax.

The external antennæ are long, filiform, and setaceous, and are placed on squamous peduncles; the inner pair have not been discovered. The two chelate hand-claws are equal, and have their surface muricated, or beset with short erect spines. The pincers are very long, not muricated, but marked with three or four longitudinal, punctated furrows; each finger is armed with a row of obtuse, cylindrical spines, which are mutually received and inserted, when the claws are shut. The claws, including the pincers, are equal to twice the length of the thorax.

There are five legs on each side; the anterior pair is didactyle; the others appear to terminate in swimmers or paddles, but this circumstance cannot be accurately determined. The abdomen is composed of six granulated arcuate segments. The tail is foliaceous, marginate, granulated, and has a few longitudinal ridges; but the only known specimen (Tab. xxx. fig. 1.) does not exhibit the entire form.

This species appears to be distinguished from the recent animals of the genus, by the dorsal ridge and lateral sulci of the thorax; the great length and straightness of the pincers; and the peculiar form of their spinous processes.

In naming this fossil in honour of Wm. Elford Leach, M.D. of the British Museum, I am desirous of testifying the high respect which I entertain for his talents as a naturalist, and particularly for his excellent systematical arrangement of the crustaceous animals.

Tab. xxix. figs. 1, 4, 5. The *chelate claws* of A. *Leachii.*
——— fig. 4. is the largest example hitherto discovered.
——— fig. 1. A fragment of the pincers of the preceding specimens.
——— fig. 5. A block of chalk, containing part of a *claw, leg,* and several detached spines; fragments of a fish are attached to the upper part of this specimen.

Tab. xxx. fig. 2; two *chelate hand-claws,* attached to the chalk in which they were imbedded.

Tab. xxxi. fig. 1: on the left of this specimen, part of the *thorax* is attached; and on the right, a hand-claw deprived of one of its pincers.

Tab. xxxi. fig. 2. Cast of the *thorax;* the head broken off.

——— fig. 3. The *thorax* flattened by compression.

——— fig. 4. Represents the most perfect specimen in my collection.

a. The head.

b. The thorax.

c. One of the long setaceous antennæ.

d. The squamous peduncle of the same.

e. One of the anterior legs, with its didactylous termination.

f. The hand-claws, and pincers.

Tab. xxxiv. fig. 9. Part of a claw flattened by compression.

Localities. Upper chalk, near Lewes, and Houghton *.

95. Astacus ———. Tab. xxx. fig. 3.

This specimen is evidently the chelate hand-claw of a species of *Astacus,* distinct from the preceding. The surface both of the claws and pincers is spinous, the latter are slightly curved, and armed with a row of obtuse tubercles.

Locality. Upper chalk, near Lewes.

96. Cancer. Tab. xxix. fig. 3.

This figure represents the chelate hand-claw of a species of *Cancer,* having a minutely granulated surface. The pincers are curved, and finely serrated on the inner edge.

Locality. Upper chalk, near Lewes.

97. Cancer. Tab. xxix. fig. 2.

The cast of the *thorax,* of a species of *Cancer,* is represented in the figure referred to. It is of an obcordate form, much depressed, the margin impressed with four or five indentations, and the front cleft in the middle.

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* A specimen, containing the chelate hand-claws, and the extremities of two legs, has lately been discovered in the chalk near Houghton, in Western Sussex, by Mr. Frederic Sargent, of Wool Lavington: to the kindness of John Drewett, Esq. of Peppering, I am indebted for an excellent lithographic drawing of this interesting fossil.

Locality. Upper chalk, near Lewes.

98. Leg of an unknown crustaceous animal. Tab. xxxiv. fig. 4.

This fossil is part of the leg of some crustaceous animal, but whether belonging to either of the genera above-mentioned cannot be ascertained; it is nearly black, and its surface highly polished.

Locality. Offham chalk-pit, near Lewes.

ICHTHYOLITES, OR THE FOSSIL REMAINS OF FISHES.

The remains of fishes are of far less frequent occurrence in a fossil state, than those of many other tribes of animals; nor will this circumstance appear extraordinary, when it is considered that the softness of their structure renders them liable to undergo putrefaction with great rapidity, and that such as die a natural death, rise to the surface of the water, and immediately become the prey of a multitude of assailants. A concurrence of circumstances, by which the destruction and envelopement of these animals maybe instantaneously effected, seems therefore necessary to the preservation of their remains in the mineral kingdom. Hence some naturalists have asserted, that wherever petrified fishes occur in considerable numbers, it may be inferred that they perished by some sudden catastrophe which destroyed and overwhelmed them in shoals, in the very spots where they are now found entombed*.

The Rev. —— Graydon †, in an interesting memoir on the fossil fish of Monte Bolca, endeavours to account for the phenomena they exhibit, by a very ingenious theory, that appears to be in perfect accordance with the facts already known on this subject. He supposes that the fishes were destroyed by submarine volcanic eruptions, by which immense masses of calcareous stone were ejected in a calcined state; and which involving the animals, &c. within its reach, subsequently became consolidated, and now forms the cream-coloured matrix of these celebrated fossils.

The mineralized remains of fishes occur in various parts of England;

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* *Rees' Cyclopædia*, Art. *Ichthyolites*. *Dict. D'Hist. Nat.* Tome viii. p. 550. *Martin's Syst. Arrangement*, p. 29.

† *Irish Transactions*, Vol. v. p. 310.

but no where more abundantly than in the chalk of the South Downs, in the immediate vicinity of Lewes.

The specimens are generally imperfect and distorted, and afford but slight indications of the form of the original; but few examples having been found, in which the number and situation of the fins, and other parts essential to the determination of the genus, or species, are distinctly exhibited. Yet, in many instances, their general characters are sufficiently defined, to prove their entire want of correspondence with any known existing species.

The teeth and palates are remarkably beautiful, their original substance being heightened by an impregnation with iron, and their natural polish and sharpness remaining uninjured. The vertebræ and other bones are of a reddish brown colour, and very friable.

The fins and scales possess a glossy surface, are exceedingly brittle, and both in colour, and in the mode of their preservation, perfectly resemble the ichthyolites of Monte Bolca.

Of the cartilaginous fishes, the teeth of several species of *Squalus* or shark, are most frequent; the vertebræ are also occasionally met with, but no decided examples of any other part of these animals have hitherto been discovered.

99. Vertebræ of an unknown species of Squalus. Tab. xxxiii. fig. 10.

The specimen here represented exhibits two vertebræ, and the section of a third, imbedded in chalk, and is part of a large mass containing eleven others. The vertebræ are concave both anteriorly, and posteriorly; but no traces of the spinous, or transverse processes remain. They resemble those of the recent Squalus *maximus;* and correspond both in size, form, and colour, with the fossil vertebræ, figured in the *Oryctographie de Bruxelles*, Pl. ii. B. G. and Pl. iii. B.

The latter are 38 in number, and articulated to each other, forming a column more than five feet long; they are thus described by Blainville*: "Dans le milieu de la pierre à chaux d'une carrière des environs de

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* *Nouveau Dict. d'Histoire Nat.* Vol. xxviii. Art. *Ichthyolites.*

Moelsbrock, a été trouvée, fossile, une série de vertèbres jointes ensemble, au nombre de 38, et formant un tout de cinq pieds, qui ne diminue dans cette longueur que de trois lignes ou plus. Il n'y a aucune trace d'apophyses. M. Burtin regarde cet ichthyolite comme provenant d'un *serpent de mer;* et par-là il est probable qu'il entend parler du *congre;* mais il se pourroit plutôt qu'il provînt d'une grande espèce de squale, qu'il est à peu près impossible de spécifier."

Locality. Upper chalk, near Lewes.

100. Teeth of Squalus *cornubicus.* Tab. xxxii. fig. 1.

The teeth of sharks are so numerously distributed throughout almost every deposit of the secondary formations, that there is scarcely an oryctological writer, who has not made mention of them. They are the *glossopetræ*, *ornithoglossæ*, &c. of the earlier authors, and have been described by Woodward, Lhwyd, Knorr, Scilla, &c.

The present species has sharp entire edges, and two sharp pointed lateral processes. The specimens are generally straight, slender, tapering, and sometimes slightly curved; the cartilaginous base is deeply arched, and has an obtuse tubercle on the centre of the outer surface. The difference observable in their forms, is probably owing either to the age of the individual, or to the situation the teeth respectively occupied in the jaw of the recent animal; the anterior being longer, and more slender, than the posterior ones.

Localities. Upper chalk near Lewes, Brighton, Steyning, &c.

101. Teeth of the Squalus *mustelus*[*]. Tab. xxxii. figs. 2, 3, 5, 6, 9, 11.

These teeth are triangular, nearly straight, and flat, with entire cutting edges; and furnished with two small acuminated lateral processes. The base of the tooth is nearly straight, and the cartilage but slightly arched.

The specimens figured are from the Upper and Lower chalk; in fig. 11 the lateral processes are destroyed.

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[*] A specimen of the recent animal, about six feet long, was caught a few years since off Newhaven; the head came into my possession, and enabled me to compare the fossil with the recent teeth; the correspondence between them was most complete, and left no doubt of their having belonged to the same species of Squalus.

Localities. Lewes, Brighton, Steyning.

102. Teeth of the Squalus *zygæna?* Tab. xxxii. figs. 4, 7, 8, 10, 26, 28.

These are either straight or slightly curved triangular teeth, with entire cutting edges, but destitute of lateral processes. It has been suggested that the latter may have been removed by accident, but this supposition does not appear tenable, since in those examples where the cartilaginous base is perfect, no vestiges of lateral points can be detected.

They bear a close analogy to Mr. Parkinson's figure of a fossil tooth of Sq. *zygæna;* but their supposed identity, with those of the recent species, must be received with some hesitation.

Localities. Upper, and Lower chalk, near Lewes, and Brighton.

103. Teeth of the Squalus *galeus?* Tab. xxxii. figs. 12, 14, 15, 16.

The width of these fossils frequently exceeds their length; the body is inclined to one side, the edges are finely serrated, and the cartilaginous base nearly straight.

The form of this species varies considerably, but the characters enumerated, readily distinguish it from those above described.

I am unacquainted with the teeth of the recent animal, and have referred these fossils to the Sq. *zygæna,* upon the authority of Mr. Parkinson, whose figure represents a specimen from the Kentish chalk, that perfectly corresponds with those of Sussex.

Localities. Lower chalk, near Lewes, and Brighton.

104. Teeth of an unknown species of Squalus. Tab. xxxii. fig. 13. Tab. xxxiii. fig. 9.

These teeth are of a lanceolate form, with serrated edges; they differ very essentially from the preceding, and probably belong to an unknown species of shark.

Locality. Upper chalk, near Lewes; very rare.

105. Tooth of a fish of the genus Squalus? Tab. xxxii. fig. 22.

This elegant little fossil resembles fig. 1276 of Lhwyd, and fig. 111 of Brander, and is supposed to be analogous to the teeth of the recent dogfish of Scilla. Mr. Parkinson mentions that a species of Squalus from

Messina, described by Spallanzani, (and which appears to agree in its characters, with the fish figured by Scilla, Tav. xxvii.) has also teeth of a similar structure. It may however be questioned, if the present specimen belongs to the same kind of animal; or whether it may not be the fin-bone of a fish allied to the *Balistes*. It consists of six sharp points or spines, anchylosed at the base, and attached to a narrow, bony or cartilaginous process.

The example figured, is probably the only fossil of the kind hitherto discovered in the chalk formation. Scilla's specimens were found in the limestone of Malta, which is situated above the chalk; and those of the English authors above referred to, were collected from different localities of the London clay.

Locality. Upper chalk, near Lewes.

106. Tooth of ——? Tab. xxxiii. fig. 7.

The fossil here represented is of a very singular character. It is of a lanceolate shape, of a dark brown colour inclining to black, and its surface is marked with numerous irregular fissures filled with chalk; this appearance is constantly observable in every specimen. The edges are acute, and entire.

I am unacquainted with any teeth, either in a fossil or recent state, that possess a similar structure.

Locality. Upper chalk, near Lewes.

The remains we are next to examine, bear considerable analogy to the corresponding parts of certain species of Balistes, or file-fish: to illustrate the subject, we shall therefore insert a brief description of the recent animals.

BALISTES.

The fishes of this curious genus, have the head compressed, and close to the body, appearing as if it were a continuation of the trunk. The mouth is narrow, the teeth in each jaw are eight in number, of which the two anterior ones are the longest; there are also three interior ones on each side, opposite the intervals between the external row. The aperture of the gills is narrow, destitute of opercula, and placed above the pectoral fins; the branchiostegous membrane has two rays. The body is compressed, and carinated on each side; the scales are coriaceous, joined together, and rough, with sharp minute prickles. *They have two dorsal fins, of which the anterior one is armed with a strong spinous ray, concealed in a deep groove in the back, and can be erected or depressed by the animal, at pleasure*[*]. Some species, as the B. *monoceros* (Unicorn file-fish), are furnished with a spine between the eyes.

107. Spine of a species of *Balistes*. Tab. xxxiii. figs. 5, 6.

The specimen delineated in fig. 5, is evidently the defence of a fish, and so strikingly resembles the spine fixed between the eyes of certain species of Balistes, that there can be no hesitation in considering it as belonging to a fish of that genus. It is of a dark chocolate colour, and possesses a fine polish; several vertebræ are imbedded in the chalk near its base.

Fig. 6, is nearly allied to the preceding, but in all probability is referable to a different species of the same genus.

Locality. Upper chalk, near Lewes.

108. Dorsal fin, or *radius*, of a fish allied to the *Balistes*. Tab. xxxix.

This magnificent specimen, is one of the most interesting productions of the Upper chalk. It was unfortunately broken by the quarry-men, and the intermediate portion destroyed: the dotted outline will, however, assist in conveying an idea of its original form.

It consists of thirteen narrow parallel rays, divided by fine sulci, that gradually diminish in size as they approach the apex, which is broken off. The rays are anchylosed, or united to each other, the grooves or furrows penetrating but a short distance in the substance of the fin. The upper edge is serrated, having fifteen obtuse projections, with corresponding depressions. The inferior margin is entire, and near the base of the fin, is furnished with numerous slender processes, or cirri, that occupy a space of three inches in length, and an inch and a half in breadth; these are probably the remains of the tendinous expansion of the muscles, by which the fin was erected, and depressed.

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[*] "Ils ont deux nageoires dorsales, dont la première présente toujours un rayon très fort, et souvent garni d'épines, qui, couché dans une fossette creusée dans le dos, peut se relever à la volonté de l'animal, avec autant de vivacité que la corde d'une arbalètre qui se détend, ce qui ne permet pas aux poissons voraces de les saisir, ou leur blesse gravement le palais lorsqu' ils les ont saisis." *Nouveau Dict. d'Hist. Nat*, Tom. ii. p. 515.

The external surface is in a great measure destroyed, but where portions of it remain, exhibits a granulated structure, like seal-skin. This appearance is distinctly seen near the two first teeth, and towards the smaller extremity. The fin is solid, and is composed of a brown brittle substance, resembling the constituent matter of the vertebræ of cartilaginous fishes found in the chalk.

It is 10·5 inches long; 3·5 wide at the base; and about half an inch thick.

In "Townsend's Character of Moses," a dorsal fin bearing a general resemblance to the present fossil is figured, Pl. xviii. figs. 1, 2, 3. Similar specimens occur also in the Blue Lias of Dorsetshire. These fins consist of parallel rays, and are armed on the upper margin with sharp spines, placed in sockets, like the teeth in the proboscis of the Pristis. It must however be remarked, that in the specimen under consideration, the tooth-like processes are prolongations of the substance of the fin, and not distinct processes; a structure that separates it from any fossils previously discovered. It differs also from the dorsal fins of the Balistes in its form, in the greater number of rays, and in the latter being anchylosed; while in the recent species the rays are but few, and placed at some distance from each other, being united by a membrane. It is therefore obvious that the fossil in question belonged to a fish, of which the recent prototype is either extinct, or unknown.

Locality. Upper chalk, near Lewes.

109. Dorsal fin of a fish allied to the genus *Balistes*. Tab. xl. fig. 3.

This fin is less perfect than the preceding, and differs from it in the tooth-like projections being larger, and more distant; those of No. 107 being twice as numerous. There can, however, be no doubt that it belonged to a different species of the same genus.

Locality. Upper chalk, near Lewes.

110. Part of a dorsal fin. Tab. xxxiv. fig. 8.

This fragment consists of five parallel rays; it differs from those above mentioned, in its surface being marked with oblique finely serrated sutures *; the interior is hollow, and filled with chalk.

Locality. Upper chalk, near Lewes.

Two other dorsal fins, apparently belonging to different species of the same tribe of fishes, have very recently been discovered. One of them is from the grey marl; it is composed of twelve or thirteen rays, the upper ones being distinct, and the lower ones anchylosed; it is ten inches long, and 1·5 inch wide at the base: both margins are entire, but it is probable that the uppermost ray may be wanting.

The other fin is imperfect; the rays are very slender, nearly cylindrical, and quite distinct from each other.

111. Teeth of fishes allied to the genus *Diodon*. Tab. xxxii. figs. 18, 19, 20, 23, 24, 25, 29.

These teeth are more or less of a quadrangular shape, having the outer surface convex, and composed of an exceedingly hard enamel, which in the centre is formed into sharp and slightly curved ridges; these are surrounded by a border of obtuse papillæ. The specimens before us exactly resemble the teeth of the *Diodon histrix*, which has one tooth of this kind affixed to the os hyoides, and another to the palate or roof of the mouth. But the fossil teeth are sometimes found in considerable numbers, and of various sizes, forming a tesselated surface of several square inches; and so regularly disposed, the smaller palates being adapted to the intervals between the larger ones, that no doubt can exist of this having been the mode in which they were placed in the original. Hence, instead of each specimen being a distinct palate, like the corresponding teeth of the Diodon, they appear to have constituted the covering of the entire roof and base of the mouth †.

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* I am informed by Mr. Konig, that a similar structure is perceptible in the fin figured by Townsend, which is now in the British Museum.

† These teeth are termed by Mr. Miller, *dentes tritores:* "they differ from the molares, in

The specimens figured are of various forms, but do not appear to be specifically distinct.

Tab. xxxii. fig. 29, differs from the preceding, in having a greater degree of convexity, in its ridges being transverse, more numerous and delicate, and the depressions less deep: it is, perhaps, referable to a different species.

The conical teeth, Tab. xxxii. figs. 17, 21, 27, although not exactly corresponding with either of those above described, may yet, in all probability, be regarded as belonging to a fish of the same genus.

Localities. Upper, and Lower chalk, in every quarry on the South Downs*.

APODES.

The fishes of this order approach very nearly to the *Amphibia nantes* of Linnè, and some of them resemble the serpent tribe. They are long and slender, having a smooth skin, which is generally naked or covered with small soft scales. Two species of fishes allied to the genus *Muræna,* are the only animals of this order that occur in a fossil state in Sussex.

112. Muræna? *Lewesiensis.* Tab. xxxix. fig. 11. Tab. xl. fig. 2.

A long cylindrical fish, of which neither the fins nor extremities have been discovered, is one of the most frequent, but most imperfect of the Sussex ichthyolites. The specimens are of a subcylindrical form, rather flattened by compression, from six inches to two feet in length, and about one inch wide. They occur abundantly in the Upper chalk, and occasionally in the siliceous nodules. They are, for the most part, perfectly straight; but some specimens are undulated, as if the fish had been suddenly enveloped in the chalk, while in a state of motion. The surface is covered with small, delicate, smooth scales, confusedly mixed together; not one

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not being affixed to the jaws." He supposes them "to have been attached to the palate bones, os hyoides, &c. of fish of the genera *Diodon*, and *Balistes*. It was their office to crush the food, fishes generally having teeth of detention in their maxillæ."

* About two years since, a block of chalk, containing upwards of a hundred of these bodies, was discovered by the workmen in Offham pit; it was sold to a stranger, or its representation would have formed a splendid embellishment to the present volume.

instance having been noticed, in which they are disposed with any degree of regularity.

Tab. xl. fig. 2, represents the usual appearance of these fossils; and Tab. xxxix. fig. 11, the only example that retains the slightest indication of a fin. In another solitary specimen, one extremity terminates in an obtuse projection, like an obscure outline of the head; it is however, too imperfect to warrant any speculation on the form of the original.

Until more illustrative specimens shall be discovered, our conjectures concerning the recent animal must be vague, and unsatisfactory. That the remains in question are referable to a fish of the order *Apodes*, cannot however be questioned, and they certainly appear to be more intimately related to the genus *Muræna*, than to any other with which we are acquainted.

In the quarries at Offham, the remains of a narrow, compressed, cylindrical body, evidently related to the preceding, are occasionally met with. They are more or less contorted, possess a glossy surface, and are of a light greenish colour; the imperfect state of the specimens prevents a more particular notice.

Localities. Upper, and Lower chalk, near Lewes, and Brighton.

THORACICI.

In the fishes of this order, the ventral fins are placed on the trunk, or nearly under the pectoral fins.

It is with some hesitation, that I refer to this division a thin compressed fish, whose remains are frequently met with in the Upper chalk near Lewes. This ichthyolite is related to the genera *Stromateus*, *Chætodon*, and *Zeus;* but in its general form, more closely resembles the recent individuals of the latter.

The fishes of the genus Zeus have the head compressed, and sloping, the upper lip arched, the tongue subulated, the body compressed, thin, and shining; and the rays of the first dorsal fin ending in filaments; in every essential particular of this description, the fossils alluded to, will be found to correspond.

113. Zeus *Lewesiensis*. Tab. xxxv. figs. 1, 2. Tab. xxxvi.

This species is from six to eight inches long; and its width is nearly equal to the length of the body, exclusive of the head. It is covered with large, ovate, striated scales; the back and abdomen are ridged, and gently arched; and the body is thin, and compressed. The head is somewhat obtuse, and large in proportion to the body; the orbits project, and are placed high in the head. The lower jaw is straight, the upper one slightly arched; and both are destitute of teeth. The *opercula branchialia* are large, and there are six branchiostegous rays. The dorsal and anal fins are placed opposite to each other, and extend over two-thirds of the posterior part of the body, but do not unite with the tail; the rays of the dorsal fin appear to pass into long filaments, as in the recent Dory. The pectoral fins have not been observed. The caudal fin, or tail, is rounded, and composed of numerous strong rays. The vertebræ are about twenty in number: in most instances the ribs still remain attached.

The above description is taken from upwards of twenty specimens, not one of which is sufficiently entire, to indicate the structure of the original, without the assistance of other examples. Those figured, are the most perfect in my possession, and will serve to illustrate the general appearance of this species. It seemed unnecessary to delineate detached parts.

Tab. xxxv. fig. 1. A portion of the body, exposing several vertebræ, with the ribs attached.

Tab. xxxv. fig. 2, and Tab. xxxvi. are corresponding parts of the same specimen. In fig. 2, the drawing is inverted, the fish being represented with the abdomen uppermost. It exhibits the anal fin, the termination of the lower jaw, and numerous remains of the bones of the head.

In Tab. xxxvi. the same parts are more distinctly shewn; and also the elongated rays of the dorsal fin, with part of the tail, &c.

Localities. Upper chalk, near Lewes, and Brighton.

ABDOMINALES.

The abdominal fishes are more frequent in the mineral kingdom, than those of any other order; they are distinguished by the ventral fins being placed behind the pectoral, or upon the abdomen. The remains of three species, belonging to as many genera, have been discovered in the Sussex chalk, all of which appear to differ from any previously noticed, either in a recent, or fossil state.

The first that claims our attention, is nearly related to the genera *Salmo* and *Clupea,* but does not entirely conform to the characters of either; it may however be convenient to affix some name as a temporary distinction, and for reasons hereafter mentioned, the following has been selected.

114. Salmo *Lewesiensis.* Tab. xxxiii. fig. 12. Tab. xl. fig. 1.

The body of this ichthyolite is of an elongated oval form, and covered with smooth, delicate, semicircular scales. The trunk is subcylindrical, the back slightly ridged, and the abdomen rounded. The head, so far as can be ascertained from the specimens in my collection, appears to have been of an obtuse form. The eyes are placed high on the head; the mouth and jaws resemble those of the *Salmo odoe,* but no vestiges of teeth are perceptible; the lips are rounded as in the Perch (Perca *fluviatilis.*) The *opercula branchialia* consist of three or four plates, and in one example ten or eleven of the branchiostegous rays remain. The pectoral fins lie close to the gill-covers, and are composed of seven or more rays. The ventral fins are attached to the abdomen, and each has six or seven rays. The dorsal and caudal fins are unknown; but the small adipose fin or process, so constantly observable between the dorsal fin and tail, in the recent fishes of the salmon tribe, is distinctly shewn in one specimen.

The ventral fins being situated behind the pectoral, places this fossil fish in the order abdominales; while the relative situation of these parts, the adipose dorsal appendage, the structure of the opercula, and the rounded form of the abdomen, prove its affinity to the salmo. The absence of teeth, and the obtuse form of the head, appear to distinguish it from the recent species.

Tab. xl. fig. 1. The body of S. *Lewesiensis* attached to a block of chalk;

it contains some traces of the tail; but no vestige of the other fins remains.

Tab. xxxiii. fig. 12, represents the head of this ichthyolite; it exposes the *jaws*, part of the *gills*, *temporal bones*, &c.

The specimens here figured, present but little information concerning the structure of the original; and it is but very lately, that the discovery of a most interesting example, has enabled me to determine its characters with precision. In the fossil alluded to, the back of the animal is imbedded in the chalk, but the abdomen, head, &c. are distinctly exposed. This fish lies three inches in relief, is nine inches long, 2·5 inches wide between the pectoral fins, and one inch between the ventral; the latter being placed three inches below the former. The relative situation of these parts may probably have been altered by compression, but the specimen is so little distorted, that the difference produced by this cause cannot be material. The head is considerably mutilated; it exhibits portions of the jaws, temporal bones, the plates of the opercula, and ten or eleven branchiostegous rays on each side; the latter are spread out from beneath the opercula, and meet under the lower jaw. Both the pectoral fins are preserved; the right one remains in its natural situation; the other is displaced, and partly covered by the gills; each is composed of seven or eight rays. The ventral fins consist of six or seven rays, and are partially separated from the body of the fish. The number, form, and situation of the dorsal fins, cannot be ascertained without removing a considerable portion of the chalk, and incurring the risk of injuring the specimen. The tail is altogether wanting.

This magnificent fossil fish, (probably one of the most interesting Great Britain has produced, was discovered too late for representation in the present volume.

Locality. Lower chalk, near Lewes.

115. Detached scales of fishes. Tab. xxxiv. figs. 1, 2, 3. 5, 6.

With the exception of fig. 6, which evidently belongs to the *Salmo Lewesiensis*, the scales here delineated, cannot with certainty be referred to any known species.

Figs. 1, and 3, are said by Mr. Konig, to resemble those of the Jew fish. Scales of this kind are figured by Knorr, in his *Monumens des Catastrophes*, but I have no opportunity of referring to that celebrated work.

Fig. 2, a scale with its process of attachment.

Fig. 5, lozenge-shaped scales, their recent analogue unknown.

Localities. Upper, and Lower chalk, near Lewes.

116. Esox *Lewesiensis.* Tab. xli. figs. 1, 2. Tab. xxv. fig. 13. Tab. xxxiii. figs. 2, 3, 4.

The specimen represented in Tab. xli. fig. 1, is one of the most remarkable fossils of the Sussex chalk. It is evidently the lower jaw of a fish, whose recent prototype is unknown. The dentature of the maxillæ in certain species of *Esox* or *Pike*, is very analogous, and in all probability, the interesting relic before us, will hereafter be found to belong to an extinct or unknown species of that genus. The engraving conveys so accurate an idea of the original, that a brief description will suffice.

The jaw is nearly perfect, and is attached to the chalk by the left side, the opposite portion lying in alto relievo. Notwithstanding the brittle nature of the specimen, the chalk has been removed from the interior, and the dentature on both sides is completely exposed*. The maxilla, including the articulating process, is nearly six inches long, but the dentated part does not exceed 3·5 inches. It is about one inch wide at the posterior part, and gradually contracts towards the front, which is only 0·5 inch wide.

There are twelve teeth remaining, viz. seven on the left side, and five on the right; these are not fixed in sockets, but united to the jaw by anchylosis. They have a glossy surface, and are exceedingly brittle; differing most essentially in this respect from those of the shark, and other fishes previously noticed. The two anterior teeth are nearly an inch in length, and possess a very peculiar form; they are broad at the base, and suddenly contracting, terminate in a point; they are convex behind, and rather channelled in front (vide fig. 2, Tab. xli.). The teeth on the left side (the uppermost row in the figure,) are of various sizes, the two posterior ones being very short; they are not attached to the edge of the jaw, but to a longitudinal depression on its inner surface. The teeth on the right side are very irregularly disposed, and appear to have suffered some degree of displacement; four of them, including the anterior tooth, are affixed to the margin of the jaw, but the penultimate one is placed nearly 0·3 inch within the outer edge*.

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* To the young collector it may not be unimportant to learn, that in clearing specimens of this kind, it is necessary to leave small brackets of chalk to support the teeth; without this precaution, the brittle nature of the latter is an insurmountable obstacle to their preservation.

Tab. xli. fig. 1, the lower jaw above described.

——— fig. 2. Front view of the anterior teeth of the same.

Tab. xxv. fig. 13. Lower jaw of *Esox Lewesiensis* in a young state.

Tab. xxxiii. figs. 2, 3, 4. Detached teeth of the same.

Localities. Upper, and Lower chalk, near Lewes.

The ichthyolite we have next to describe, is in all probability abdominal, but the situation of the fins is so imperfectly shewn, that even this point cannot be positively ascertained. The determination of its generic characters is involved in still greater obscurity, since there does not appear to be any recent genus to which it can be correctly appropriated. It bears some affinity to the *Antherina*, *Mugil*, and *Polymnemus*, but possesses characters obviously distinct from either of those genera. In the elongated form of the body, the number and situation of the fins, and in the dentature of the jaws, it resembles an ichthyolite figured by Cuvier†; and which is considered by that illustrious naturalist, as approaching to the *Amia calva*‡ of Linné.

Both the fossils in question differ however from each other, and from the recent species, in many important particulars; and although it is probable they will hereafter be found to be but very remotely related, yet in the present infancy of oryctological science, it may be excusable to retain them under the same genus, until their characters shall be accurately determined, by the discovery of more illustrative specimens.

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* Whether this is the result of accident or of original conformation, cannot perhaps be determined. It is not however improbable, that the original may have been provided with two sets of teeth in each maxilla, the outer row being attached to the margin of the jaw, and the inner set, to a depression on the inner surface; the teeth of the latter, being placed opposite to the intervals left between those of the former.

† *Fossiles de Paris; Reptiles et Poissons*, fig. 13.

‡ The *Amia calva* is a fresh water fish, inhabiting the rivers of Carolina.

117. Amia? *Lewesiensis.* Tab. xxxvii. xxxviii.

The length of this ichthyolite generally exceeds eighteen inches, the head being equal to one-third of the whole; the width is about 4·5 inches. The body is of an elongated form, slightly compressed, scaly, and reticulated.

The scales are of a rhomboidal shape, and beset with numerous, small, adpressed spines, producing a scabrous reticulated appearance, not unlike the surface of some kinds of Balistes. The head is angulated; the orbits large; the opercula smooth, and rounded; the jaws dentated, and nearly straight. The teeth in the upper maxilla are conical, pointed, and rather flat; there are about forty on each side, of which the eight or nine anterior ones, are the largest. Those of the lower jaw are exceedingly small, and very numerous. The dorsal fins are two in number; the anterior one (*a.* Tab. xxxvii.) is placed in a sulcus, or groove, in the back, and appears to have been capable of erection or depression; it consists of eight strong rays, the two first being garnished with spines. The posterior dorsal fin (*b.* Tab. xxxvii.) is remote from the other, and composed of numerous delicate rays. The pectoral fins are placed on the thorax, near the lower margin of the opercula. The ventral fins (*c.* Tab. xxxvii.) are attached to the abdomen, opposite to the anterior dorsal fin. The anal fin is unknown. The tail appears to have been rounded, but no perfect specimen of this part has been obtained. The tongue is occasionally preserved, (vide Tab. xxix. fig. 6. Tab. xxxiv. fig. 7.) It is of a triangular form, and its surface is covered with numerous papillæ. The air bladder is of an elongated oval shape, and lies in the abdomen, immediately beneath the spine*.

From the preceding description, which comprehends all that is at present known concerning this curious ichthyolite, the original appears to have borne some resemblance to the *Mugil;* but its dentated maxillæ, not to mention other obvious differences, distinguish it from the recent individuals of that genus.

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* It may seem scarcely credible, that a part of such delicate structure, should be preserved in a mineralized state, yet the fact is unquestionable; I have three specimens in my collection, in which it is clearly shewn.

The structure and situation of the anterior dorsal fin, and the reticulated scabrous surface of the body, is similar to what is observed in some species of *Balistes;* but the fossil before us, does not present the slightest analogy in any other respect, to that tribe of fishes.

The specimen figured by Cuvier, and described by Blainville, under the name of *Amia ignota**, possesses many characters in common with the fossil before us. It consists of the skeleton of a fish, attached to a block of gypsum. It is twelve inches long, and four inches high; the head being equal to one-third of the length. It has two dorsal fins occupying the same relative situation with those of the Sussex fossil; the ventral fins also correspond; the lower jaw is furnished with many small pointed teeth, and the tail is rounded. But the angular form of the head in A.? *Lewesiensis:* the spinous rays of the anterior dorsal fin, and the scabrous structure of the scales, separate it most decidedly from the A. *ignota* of the French naturalists.

Tab. xxxvii. A portion of the body of Amia? *Lewesiensis.*
- *a.* The anterior dorsal fin.
- *b.* The posterior dorsal fin.
- *c.* One of the ventral fins.

The whole surface is covered with scales in an excellent state of preservation.

Tab. xxxviii. A specimen imbedded in chalk, the scales being almost entirely removed.
- *a.* The lower margin of the orbit.
- *b.* The maxillæ, with two teeth in the upper jaw. In another example the teeth are preserved in both jaws.
- *c.* The impression of one of the opercula branchialia.
- *d.* One of the ventral fins.
- *e.* The air bladder.

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* *Nouveau Dict. d'Hist. Nat.* Tom. xxviii. *Art. Ichthyolites*, p. 69.

Tab. xxix. fig. 6, the tongue detached from a large specimen.

Tab. xxxiv. fig. 7, a vertical section of the head, the tongue remaining in situ.

Locality. Lower chalk, near Lewes.

118. The lower jaw; vertebra, &c. of an unknown fish? Tab. xlii.

The fossils delineated in this plate were imbedded in the same block of chalk, and most probably belonged to the same individual. They consist of part of the lower jaw, several tusks or defences, a vertebra, and a cylindrical bone.

The jaw, fig. 1, of which the right side only remains, is attached to the chalk, by its inner surface, the exterior being exposed. It is 5·5 inches long; 1·2 inch wide; and 0·5 inch thick in front: it contains twelve smooth pointed teeth. These are slightly convex, very brittle, and possess a glossy surface.

The three anterior ones are gently curved; their fangs are hollow, and placed in sockets that extend almost to the base of the jaw. The nine posterior teeth are of a lanceolate form, and probably destitute of fangs, appearing as if attached to the jaw by anchylosis. The two anterior and posterior teeth of this set, are placed close to each other; one of them is very small and delicate. A fragment of bone is imbedded immediately above the posterior part of the jaw; and although it is too imperfect to admit of any satisfactory conjecture of its nature, yet there seems reason to suppose, that it may be the remains of a palate bone.

The specimens figs. 3, and 4, are corresponding portions, and were by accident broken from the front of the jaw; but the edges of the respective pieces were so much mutilated, that I have been unable to ascertain the precise situation they originally occupied. They consist of a portion of the jaw, with the remains of five tusks or defences, only one of which is entire; these resemble the teeth in the fossil figured by Faujas St. Fond, *Hist. Nat. de la Montagne de St. Pierre*, Tab. xix. fig. 10; which that distinguished naturalist describes as "*Portion de machoire d'un poisson inconnu.*"

The vertebra (fig. 2.) is deeply concave on both sides, and the inner surface is marked with numerous annular ridges; a small portion of the spinous process still remains.

The bone (fig. 5.) is cylindrical in the centre, but the two extremities are nearly flat, and extend in opposite directions. These parts have suffered so much from compression, that it is scarcely possible to ascertain their original shape. It seems probable that they were once convex, and formed articulating surfaces; if this opinion be correct, the bone may, perhaps, have been a humerus.

Of the nature of the original animal, I must confess myself incapable of offering any satisfactory conjectures: the fangs of the anterior teeth, like those of the crocodile, are hollow, fixed in sockets, and not attached to the jaw; but their smooth polished surface, and flattened form, separate them most decidedly from the animals of that tribe. The posterior teeth are affixed to the edge of the jaw, a mode of dentature observable in many kinds of fishes. The structure of the vertebra is decidedly that of a fish, the conical cavities being very deep; and it possesses the annular markings so constantly observable in the vertebræ of fishes. The cylindrical bone is too much injured to allow of any correct inference being drawn from it. From these circumstances it seems probable, that the remains before us are those of an osseous fish, of a species, and perhaps genus, distinct from any previously known.

Locality. Upper chalk, near Lewes.

119. Vertebræ of the fossil MONITOR of MAESTRICHT.

Tab. xxxiii. fig. 13. Tab. xli. fig. 3.

The quarries of St. Peter's mountain, near Maestricht, have been long celebrated for the remains of one of the most extraordinary oviparous quadrupeds, hitherto discovered in a fossil state. Several magnificent specimens of the skeleton of this animal, are figured and described in the splendid work on the fossils of that mountain, by Faujas St. Fond; and the nature of the original has been ably elucidated by M. le Baron Cuvier.

These remains have not previously been noticed in England; and indeed, have been found in the immediate vicinity of Maestricht only; where they occur in a soft, yellowish, calcareous freestone. This limestone reposes upon the flinty chalk, and contains beds of flints perfectly resembling those of the chalk formation.

The vertebræ represented in the figures above referred to, are from the Upper chalk, near Lewes; and being found in the same quarry, and at a short distance from each other, may probably have belonged to the same individual. Like those of the *crocodile*, *monitor*, *inguanas*, and the greater part of the saurian animals, they have the body convex posteriorly, and concave anteriorly; a structure, that distinguishes them from those of the cetacea, and fishes.

The bone, fig. 13. Tab. xxxiii. appears to correspond most completely with the posterior dorsal vertebræ in the spinal column of the Maestricht monitor, figured by Faujas, Pl. 52; particularly with the third and fourth vertebræ, reckoning from the left hand of the specimen. The body of the vertebra is rather compressed, about two inches long, and 1·4 inch high; the face is slightly elliptical. The convexity of the posterior extremity is but slight, and the concavity of the opposite side of a corresponding depth, the surface being perfectly plain and smooth. The spinous process, of which a fragment only remains, is compressed, and occupies the anterior four-fifths of the body of the vertebra.

The specimen fig. 3. Tab. xli. contains two vertebræ articulated to each other. They are shorter than the one above described, and each has an inferior apophysis. In their general characters, they resemble the vertebræ delineated in Pl. vii. and viii. of Faujas; their bodies are compressed, and their length and height nearly equal; their faces are elliptical in a vertical direction, the transverse diameter being 1·1 inch, and the longitudinal 1·5 inch. The dorsal apophyses are narrower than in the preceding example. The inferior apophysis is strong, and rounded at the base, and suddenly contracts into a spinous process, which when entire, was probably several inches in length. As this appendage is placed rather laterally, it was suspected that another might exist on the opposite side, and that the union of the two would form a triangular bone, corresponding to the *l'os en chevron* of the crocodile, and other animals of the lizard tribe. To ascertain this point, the chalk was removed so far as was practicable, but not the slightest trace of another process could be discovered. This circumstance puzzled me exceedingly; and the difficulty of explaining it was increased, upon perceiving that the apophyses in question were perfectly anchylosed to the bodies of the vertebræ, and not united by suture, as in the recent lacertæ. A careful perusal of Cuvier's observations on the osteological characters of the monitor of Maestricht, enabled me, however, to explain this apparent want of agreement, in a very satisfactory manner; the researches of that philosopher having shewn that the *posterior caudal vertebræ* possess the structure here described, "*l'os en chevron n'y est plus articulé, mais soudé, et fait corps avec elles.*" The situation of this inferior process, presents also another striking proof of the identity of the vertebræ before us, with those of the Maestricht monitor. In the lizard tribe in general, the chevron bone is placed at the *junction* of the vertebræ; and in the monitor, at the *posterior* part; but in the animal of St. Peter's mountain, it is attached to the *middle* of the vertebræ, as in the specimens before us.

That the reader may form his own opinion upon this interesting subject, Cuvier's anatomical description of the vertebral column of the Maestricht animal, is here subjoined. The extract is rather long, but it will not be deemed irrelevant, when the importance of extreme accuracy in these researches is duly considered.

"Toutes ces vertèbres, comme celles des *crocodiles*, des *monitors*, des *inguanes*, et en général de la plupart des sauriens, et des ophidiens, ont leur corps concave en avant, et convexe en arrière, ce qui les distingue déjà notablement de celles des cétacés qui l'ont à-peu-près *plane*, et bien plus encore de celles des poissons, où il est creusé des deux côtés en cône concave.

"Les antérieures ont cette convexité et cette concavité beaucoup plus prononcées que les postérieures. Quant aux apophyses, leur nombre établit cinq sortes de ces vertèbres.

"Les premières, ont une apophyse épineuse supérieure, longue et comprimée; une inférieure terminée par une concavité; quatre articulaires dont les postérieures sont plus courtes et regardent de dehors, et deux transverses, grosses et courtes; ce sont les dernières vertèbres du cou et les premières du dos. Leur corps est plus long que large, et plus large que haut; les faces sont en ovale transverse, ou en figure de rein. D'autres, ont l'apophyse inférieure de moins, mais ressemblent aux précédentes pour le reste; ce sont les moyennes du dos.

"Il en est ensuite, qui n'ont plus d'apophyses articulaires; ce sont les dernières du dos, celles des lombes, et les premières de la queue; et leur place particulière se reconnoît à leurs apophyses transverses qui s'allongent et s'aplatissent. Les faces articulaires de leur corps sont presque triangulaires dans les postérieures.

"Les suivantes ont outre leur apophyse épineuse supérieure et les deux transverses, à leur face inférieure deux petites facettes pour porter l'os en chevron; les faces articulaires de leur corps sont pentagonales.

"Puis il en vient qui ne differènt des précédentes que parcequ'elles manquent d'apophyses transverses. Elles forment une grand partie de la queue, et les faces de leur corps sont en ellipses, d'abord transverses, et ensuite de plus en plus comprimées par les côtés. L'os en chevron n'y est plus articulé, mais soudé, et fait corps avec elles.

"Enfin, les dernières de la queue finissent par n'avoir plus d'apophyses du tout.

"A mesure qu'on approche de la fin de la queue, les corps des vertèbres se raccoursissent, et presque, dès son commencement, ils sont moins longs que larges et que hauts. Leur longueur finit par être moitié moindre que leur hauteur [*]."

From this investigation, I think we may, without hesitation, refer the vertebræ before us to the fossil animal of Maestricht [†]. The specimen Tab. xxxiii. fig. 13, is evidently one of the posterior dorsal vertebræ; those represented in Tab. xli. fig. 3, are two of the posterior vertebræ of the tail.

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[*] *Animaux Fossiles.* Tome iv. *Animal de Maestricht*, p. 20, 21.

[†] This opinion is confirmed by the observations of Mr. Konig, who obliged me by comparing the drawings of the Sussex specimens, with the vertebræ of the Maestricht monitor, in the British Museum; and expressed himself perfectly convinced of their identity.

In conclusion, it may be observed, that Cuvier has ascertained that the original animal formed an intermediate genus, between the lizards with a long and forked tongue, including the *monitors* and *common lizards;* and those with a short tongue, and dentated palates, comprising the *inguanas, marbres,* and *anolis.* This genus, he thinks, would only have been allied to the crocodile, by the general characters of the lizards. The length of the entire skeleton appears to have been nearly twenty-four feet; the head being equal to a sixth of the whole length. The tail must have been very strong, and the width of its extremity so considerable, as to have rendered it a powerful oar, by which the animal could stem the most agitated waters.

From this peculiar structure, and from the character of the organic remains with which those of the Maestricht animal are associated, there is every reason to conclude, that the original was an inhabitant of the ocean; a circumstance very remarkable, since none of the existing lacertæ are known to live in salt water*.

Locality. Upper chalk, near Lewes.

120. A conical striated tooth; probably of some species of lacerta? Tab. xxxiii. fig. 1.

This specimen is of a conical form, with the apex truncated, and the surface finely marked with longitudinal grooves, and striæ.

It bears some resemblance to the teeth of the Ichthyosaurus, Crocodile, &c. but does not possess characters sufficiently decisive, to admit of its being appropriated to any of the recent or fossil lacertæ. As a rare production of the chalk, it is worthy of notice, and it affords another proof of the little that is at present known, concerning the organic remains of the chalk formation.

Locality. Upper chalk, near Lewes.

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* Vide Cuvier's interesting description of the remains of the animal of Maestricht. *Anim. Foss.* Tome iv.

XIV.

§ III. FORMATIONS ABOVE THE CHALK.

The flat maritime district, extending on the south side of the Downs, from Emsworth and Bracklesham, to Brighton, is composed of various deposits of clay, sand, and brick-earth, reposing upon the chalk. Accumulations of similar materials, enclosing waterworn blocks of sandstone, and boulders of a coarse, ferruginous breccia, occur also at Falmer, Lewes, Piddinghoe, Newhaven, and Chimpting castle. These are evidently the ruins of strata that formerly existed above the chalk, and were probably of considerable thickness, extent, and variety.

The class of deposits to which these belong, were but imperfectly known, till the researches of M. M. Cuvier, and Brongniart, in the environs of Paris. The publication of their masterly delineation of the *Géographie Minéralogique*, of that district, excited universal attention, and attached to the investigation of these strata a high degree of interest and importance. The inquiry was pursued with equal zeal and success, in our own country, by Mr. Webster, who discovered in London, Hampshire, and the Isle of Wight, a series of beds, corresponding in their characters, and geological position, with those of the neighbourhood of Paris. Insular portions of these strata have subsequently been noticed in numerous localities of the English chalk, and the facts already known, are sufficient to warrant the conclusion, that they were formerly as extensive in this island, as on the continent.

To enable geologists to identify the English formations with those of other countries, Professor Buckland has constructed a tabular arrangement, which is admirably adapted to facilitate the acquirement of a correct knowledge of their geological relations. As this table will materially elucidate the nature of the tertiary deposits of Sussex, and has hitherto appeared only in a periodical work*, we shall subjoin that part of it which relates to the present subject.

A Tabular Arrangement of the Rocks that occur in England, with their Equivalents in certain Districts on the Continent. By the REV. WM. BUCKLAND, *Professor of Mineralogy and Geology in the University of Oxford, F.R.S. &c.*

ENGLISH FORMATIONS.	FORMATIONS ON THE CONTINENT.
ALLUVIUM†.	ALLUVIUM.
Effect of causes now in action.	*Effect of causes now in action.*
Mud of rivers, deltas, gravel of torrents.	Same as in England, but on a larger scale.
DILUVIUM.	DILUVIUM.
The effect of causes no longer in existence.	*The effect of causes no longer in existence.*
Gravel and rolled blocks both on hills and in vallies, not produced by any causes now in action.	Same as in England.
Gravel of the vallies of the Thames, Severn, and Humber.	Superficial gravel covering the regular tertiary strata of the vallies of the Po, the Danube, and Geneva.
Blocks of Cumberland granite in the plain of Shropshire, near Bridgenorth; and of Galway granite at Shalk, on the S.W. of Carlisle in Cumberland.	Granite blocks on the Jura, above Neufchatel, and on the Saleve mountain, near Geneva.
TERTIARY FORMATIONS.	
London and Hampshire basins.	Basin of Paris, vallies of the Po, the Danube, and Switzerland.
1. *Freshwater Limestone.*	1. *Calcaire d'Eau Douce.*
Headen Cliff, Isle of Wight.	Basin of Paris; Frienisberg, near Bernis; St. Sapphorin, near Vevey; Horgen, near Zurich; Locle on the Jura; valley of the Rhine, three miles N.E. of Basle. These are principally composed of marl stone, and contain beds of coal with freshwater shells intermixed. Oeningen, near Schaffhausen, with fresh water fish.

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* *Annals of Philosophy, June*, 1821. p. 462.

† In this table Professor Buckland commences with the uppermost or newest deposits, a method directly the reverse of that which has been adopted in the present volume.

2. *London Clay.*	2. *Calcaire Grossier of Paris.*
Highgate Hill, London.	Verona, Vicentine Hills, and Monte Berici, in the valley of the Po. Loretto, S.E. of Vienna, in the basin of the Danube, Tour de Moliere, E. of Yverdun, in Switzerland.
With plants and marine fish.	With plants and marine fish.
Isle of Sheppey.	Monte Bolca near Verona. Solenhofen near Pappenheim, (probably). Fish of Mount Lebanon, (probably).
3. *Plastic Clay Formation.*	3. *Plastic Clay Formation.*
Clay, marl, sand, and gravel, with marine shells. Basins of London, Hants, and Dorset.	Beds of clay, marl, sand, and gravel, with marine shells. Basin of Paris. All the edges of the plains of Lombardy, near Parma, Placenza, Asti, Turin, Vicenza Valley of the Danube. Valley of Geneva and Constance.
4. *Puddingstone of Hertfordshire.*	4. *Nagelflue of Switzerland, Como, and Saltzburg.*
Druid sandstone blocks of Buckinghamshire, Wilts, Dorset, and Sussex.	Puddingstone of Riga near Lucerne, and of Bregentz, of Lake Constance.
5. *Lignite and Glance Coal. Imperfect Wood Coal.*	5. *Lignite and Glance Coal. Perfect, and used for Fuel.*
Alum Bay, Isle of Wight.	Monte Bolca and Arzignan in the Vicentino. Fussen in Bavaria.
Corfe clay pits, Isle of Purbeck.	Titmoning, Teisendorf, Miesbach, and all the coal-pits in the valley of the Danube above Vienna. Marburg in Styria. Leoben in Styria.

It is not implied that the above five subdivisional parts of the tertiary formations, maintain the same relative order of succession in England, and on the Continent; most of them probably alternate, but they are all more recent than the chalk of England, France, and Italy.

SECONDARY FORMATIONS.

Chalk.

Large proportion of the S.E. of England.	Craie of the French, encircling and forming the base of the basin of Paris. Younger Alpine limestone of the Euganean and Vicentine Hills in Italy. Fort near Lunenburg, close to the town on the side of Hamburgh. Castle of Cracow in Poland.

*Green Sand**.	*Craie Inferieur of the French.*
Large proportion of the S. E. of England.	Quader sandstien, and Planer Kalk, of Werner. Younger Alpine limestone of Savoy, forming the summit of the high ridge from Mount Varens in the vale, of the Arve, of Diableret, in the Rhone valley.

In the preceding arrangement, the excavations or hollows in the chalk, containing the tertiary formations, are termed basins; and these are farther distinguished by the names of their principal localities: thus we have the Paris, London, and Isle of Wight basins; the two last mentioned, comprehend the whole of the tertiary beds that have been noticed in England.

According to the plan of the present work, the alluvial and diluvial beds, will be hereafter described. The freshwater limestone does not occur in this county; the Druid sandstone, Plastic clay, and London clay are therefore the only members of the series that come under examination in this section.

The Druid sandstone occurs in the form of boulders, promiscuously scattered over the surface, or imbedded in diluvial deposits. The Plastic and London clay occupy a considerable extent of country, and form the low maritime district of the south-western part of Sussex. These beds are supposed by Mr. Webster to have belonged to the Isle of Wight basin; to obtain a clear idea of their geological relations, it will therefore be necessary to take a brief view of the extent, and characters, of that celebrated depression of the chalk.

The district comprehended by the Isle of Wight basin, is about 100 miles in length, and at its greatest breadth does not exceed twenty miles. The southern side is formed by the highly inclined chalk, extending from the Culver Cliffs, at the east end of the Isle of Wight, to White Nose, in Dorsetshire, five miles west of Lulworth; the north side by the South Downs, that pass from Beachy Head, to Dorchester, in Dorsetshire. The strata of which these hills are composed, dip generally from 15° to 5° to the south; the inclination varying in different places. The south side of the basin must therefore have been extremely steep, while the slope of the north side was very gentle. The western margin cannot be distinctly traced, and the eastern is now entirely destroyed, the sea flowing through the opening*.

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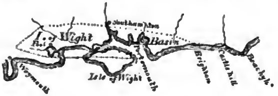
* Professor Buckland continues this arrangement down to the Greywacke, of the transition series.

The strata contained in the Hampshire or Isle of Wight basin, form five principal divisions, viz.

1. Lowest marine formation over the chalk, including the plastic clay and sand, together with the London clay.
2. Lowest fresh water formation.
3. Upper marine formation.
4. Upper fresh water formation.
5. Alluvium.

The annexed sketch will illustrate this description, and shew the connexion between the outlying fragments of these beds in Sussex, and those of the Isle of Wight.



The remains of the tertiary formations that occur in Sussex, admit of the following arrangement; it must however be remarked, that from the ruin and displacement to which they have been exposed, it is scarcely possible in every instance accurately to determine their geological positions.

Tertiary Formations in Sussex.

1. Druid sandstone.	Boulders of siliceous sandstone, sometimes enveloping pebbles, and forming a breccia resembling that of Hertfordshire.	Scattered over the surface of the Downs, near Falmer, Brighton, Lewes, &c.

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* *Mr. Webster on the Strata overlaying the Chalk. Geolog. Trans.* Vol. ii. p. 170, et seq.

2. Plastic Clay.	Beds of clay, marl, sand, &c. resembling those of Woolwich.	Castle Hill, near Newhaven. Chimpting castle, &c.
3. London Clay.	Blue clay containing shells.	Bracklesham, in the Isle of Selsea.
	Greenish grey sandstone.	Bognor Rocks; Barn Rocks, between Selsea and Bognor; Houngate, and Street Rocks, west of Selsea.

XV.

§ III. 9. DRUID SANDSTONE.

IMMENSE blocks and boulders of siliceous sandstone, composed of granular quartz, and occasionally enveloping chalk flints, and other extraneous bodies, lie scattered over the Downs, and on the ploughed lands, near Brighton, Falmer, and other places. This sandstone is perfectly analogous to that which occurs in Berkshire and Wiltshire, where it is distinguished by the provincial term of "*Grey Weathers.*" Of this substance, Stonehenge and other druidical monuments are composed, a circumstance that has given rise to its present geological appellation. The cement of the beautiful conglomerate or puddingstone of Hertfordshire, agrees in its characters with the druid sandstone, and from that breccia also occurring in detached blocks above the chalk, it is now generally supposed that they are both of contemporaneous origin; the siliceous deposition, when it did not envelope any foreign substance, forming the rock called the "*Grey Weathers,*" and when it fell among pebbles of any kind, composing a breccia or *puddingstone*[*].

Professor Buckland, and Mr. Webster, have ably investigated the geological history of this substance, and it affords me much pleasure to be able to corroborate their opinions, by the discovery of blocks of the sandstone under circumstances similar in this county.

The puddingstone is exceedingly rare in Sussex, but specimens sometimes occur; and I have several examples from the vicinity of Newhaven, that could not be distinguished from the Hertfordshire breccia.

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[*] *Geological Transactions,* Vol. ii. p. 225.

Examples of the siliceous sandstone may be seen on the hill near Lewes Race-course; at Bormer; in Stanmer Park; and on the ploughed lands near Hogshrove farm. At Falmer, the pond that supplies the village with water is surrounded with large masses of this substance. These boulders have their edges rounded and even, and exhibit incontestable proofs of long exposure to the action of the waves. They are of various sizes, some of them exceeding nine feet in length; their colour is either white, or of different shades of grey, and reddish brown. Their texture is subcrystalline; the white varieties, when recently broken, much resembling lump sugar. In a few instances they enclose chalk flints slightly worn, and small fragments of a dark green substance, the nature of which is unknown.

Boulders of druid sandstone also occur in the shingle bed, and calcareous deposit, at Brighton, and may be observed lying on the sea-shore in considerable numbers, after a recent fall of the cliffs.

Upon comparing the sandstone of Stonehenge with that of Sussex, no perceptible difference can be detected; and in this county, as well as in Wiltshire, it has been employed by the earlier inhabitants, as landmarks to denote the boundaries of towns*, and villages, or to commemorate the site of battles; as sepulchral stones, to perpetuate the memory of their chiefs; and as altars, on which to sacrifice to their gods.

No regular stratum of the druid sandstone has yet been discovered in this country, and its geological position is still undetermined. In the tabular arrangement of Professor Buckland, it is placed *below* the plastic clay†; and if the cliffs at Brighton (hereafter described) belong to that formation, there is conclusive evidence, that the appropriation is correct.

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* The frequent occurrence of large smooth blocks of stone, on the boundary line of villages and parishes, in the south-eastern part of Sussex, must have been noticed by many of my readers. A large boulder of druid sandstone placed at the corner of *Ireland's Lane*, in St. Ann's parish, forms the western boundary of the borough of Lewes. Similar stones are not unfrequent in the large tumuli on the Downs; several may be seen near Lewes Race-course. It seems probable, that the ancient Britons regarded this sandstone with superstitious veneration; for besides employing it in the construction of their temples, kist-vaens, &c., they converted the pebbles and smaller stones into amulets and beads.

† On a former occasion, this gentleman referred it to the plastic clay formation; and con-

It appears to be more nearly related to the "*Calcaire siliceux*" of M. M. Cuvier, and Brongniart, than to any other of the tertiary formations of France*; but that deposit is stated to lie above the plastic clay†: future observations can alone reconcile this discrepancy of opinion.

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sidered it as a member of that series of irregular alternations of beds of clay, sand, and gravel. *Geological Transactions*, Vol. iv. p. 301.

* My friend, Chas. Lyell, Jun. Esq. of Bartley Lodge, Hampshire, upon seeing the boulders of druid sandstone in the vicinity of Lewes, was immediately struck with their resemblance to those of the *Calcaire siliceux* in the forest of Fontainbleau.

† CALCAIRE SILICEUX.—" La formation dont nous allons parler, est dans une situation géologique parallèle, pour ainsi dire, à celle du culcaire marin. Elle n'est située ni au-dessous d'elle, ni au dessus, mais à côté, et semble en tenir la place dans l'immense étendue de terrain qu'elle recouvre à l'est et au sud-est de Paris. Ce terrain est placé immédiatement *au-dessus des argiles plastiques*." *Geograph. Min.* p. 29.

XVI.

§ III. 10. PLASTIC CLAY FORMATION.

In conformity with the nomenclature of M. M. Cuvier, and Brongniart, a principal division of the tertiary formations, consisting of various beds of sand, clay, marl, and gravel, is distinguished by the name of Plastic Clay. (*Argille Plastique*). An attentive examination of the general points of resemblance in the physical characters, and organic remains, of these irregular alternations above the chalk, leaves no doubt of their being members of a series of nearly contemporaneous depositions, intermediate between that formation and the London clay*.

A fine series of beds belonging to this division, occurs at Castle Hill, on the western side of Newhaven harbour, lying upon the chalk cliffs, which are there about fifty feet high. The summit of the hill is broken and rugged, and its appearance differs so remarkably from the smooth rounded surface of the surrounding downs, that the geologist, even at a distance, would suspect the existence of strata of a very dissimilar character to any that exist in its vicinity. Towards the sea it presents a steep declivity, having numerous shelvings, and fissures, occasioned by repeated slips of the strata. On the eastern brow, an ancient circular entrenchment still remains; and from this point the beds extend about one mile westward, where the chalk cliffs are covered only by a thin layer of ochraceous clay, and vegetable mould. These deposits were first noticed by Henry Warburton, Esq. F. R. S., secretary to the Geological Society, &c., and have subsequently been described by Mr. Webster, and Professor Buckland*.

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* *Geological Transactions*, Vol. iv. p. 209.

SECTION OF THE STRATA AT CASTLE HILL, NEAR NEWHAVEN.

(*Beginning with the lowermost deposit.*)

(Vide Tablet vi.)

		Thickness.
1.	Chalk with flints, - - - -	50 feet.
2.	Ochraceous clay, containing *hydrate* and *subsulphate of alumine*, and *crystallized sulphate of lime*, about - -	1½ foot.
3.	*Breccia* of green sand and chalk flints, the latter covered with a *green* and *ferruginous* crust, - - -	1 foot.
4.	Sand, of various shades of yellow, green, and ash colour,	20 feet.
5.	Blue clay with *marl of a sulphur yellow colour;* including large crystals of *sulphate of lime*, with *fibrous* and *foliated* gypsum, - - - - - -	20 feet.
6.	A seam of *surturbrand*, or *coal;* about - - -	6 inches.
7.	Indurated reddish brown marl, the lower part slaty, containing *impressions of leaves*, and casts of *cerithia*, *cyclades*, &c.	a few inches.
8.	Blue clay, containing an immense number of shells, chiefly of the genus *cerithium;* teeth of a species of *squalus*, &c. This bed is traversed by a seam of *pyrites*, a few inches thick, containing casts of *cerithia:* - - - -	10 feet.
9.	Blue clay with broken bivalve shells, apparently of the genera *cytherea*, and *cyrênê*, - - - - -	
10.	A bed composed almost entirely of oyster shells held together by an argillaceous cement, about - - - -	5 feet.
11.	Diluvium, consisting of yellow and fawn coloured sand, with	

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* Residing within a short distance of Castle Hill, the interesting character of its beds had long since engaged my attention; but from want of leisure to arrange the notes I had taken, my observations have been anticipated by the gentlemen above named in every important particular.

pebbles; the latter evidently formed of broken chalk flints
rounded by attrition, from - - - 10 to 15 feet.

The ochraceous clay (No. 2) contains the substance that has rendered Castle Hill so interesting to the mineralogist—the *subsulphate* of *alumine*. As this mineral is peculiar to Sussex, or at least has not been discovered elsewhere in England, a particular description of it must not be omitted.

Hydrate and *subsulphate* of alumine. *Brit. Min.* Tab. 499. *Annals of Philosophy*, Vol. ii. p. 238.

This substance is imbedded in a layer of ochraceous clay that lies immediately upon the chalk. The bed is situate nearly midway between the summit of the cliffs and the sea-shore, and therefore cannot be examined without much difficulty, and exposure to considerable danger*.

The first specimen of the subsulphate was discovered by the author among some gravel that had been brought from Newhaven, and was lying in a wharf near Lewes†. A few months afterwards, Mr. Webster, in a geological excursion along the Sussex coast, collected a specimen at Newhaven. This was analyzed by Dr. Wollaston, and found to consist of alumine, in combination with sulphuric acid, and a small proportion of silex, lime, and oxide of iron.

This mineral occurs massive, in veins, and in tabular and tuberose masses; the former frequently attaining several feet in length, and the latter exceeding three or four pounds in weight. It appears to have been of stalactitical origin, and is supposed to result from the decomposition of iron pyrites, and the reaction of other substances. As the superincumbent strata contain all the elements necessary for its production, it probably has been introduced into its present situation by infiltration‡. When pure, it is perfectly white, but is generally more or less discoloured by an intermixture of yellow clay. It is dull and opaque, with an earthy fracture, and yields to the knife. It is infusible at 166° of Wedgwood[*], but fuses rapidly when exposed to the stream of the hydro-oxygen blow-pipe: the result is a pearl white translucent enamel, a partial combustion taking place during its fusion[†]. According to Stromeyer it consists of

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* Specimens may generally be found among the ruins of the cliffs that lie scattered on the shore, from half a mile to a mile west of Newhaven harbour.

† Vide Mr. Sowerby's description of this substance in British Mineralogy.

‡ *Professor Buckland on the Plastic Clay. Geological Transactions*, Vol. iv. p. 294.

Alumine, -	30
Sulphuric acid,	24
Water, -	45[‡]

Crystals of gypsum are frequently disseminated through the masses of alumine, and the two substances enter into various states of combination, sometimes giving rise to specimens that are semitranslucent. Chalk flints, indurated ochraceous clay, and other extraneous bodies, are also occasionally enveloped.

From the recent experiments of Dr. Clarke, it appears that the purer masses of aluminite are destitute of sulphuric acid, and consist simply of water and aluminous earth. Hence a suspicion has arisen that the sulphuric acid in the examples analyzed by Stromeyer, and Dr. Wollaston, may have originated from the presence of gypsum; this, however, is not the case, since in many specimens it is evident that the sulphate of lime has been decomposed, and the sulphuric acid entering into combination with the alumine, has formed a true subsulphate.

The hydrate occurs in friable masses, of the colour and consistence of magnesia: it adheres to the tongue, and may be reduced to powder between the fingers. In this respect it differs from the subsulphate, which possesses considerable hardness, and is susceptible of a fine polish [§].

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[*] *Kirwan.*

[†] *History of the Gass Blow-pipe, by E. D. Clarke, LL.D.* 8vo. 1819, p. 56. The experiments of my brother gave similar results.

[‡] *Phillips' Mineralogy*, 2d edition, 1819. p. 111.

[§] In the elegant compendium of geology, inserted in Professor *Brand's Manual of Chemistry*, are the following observations on this subject:

"In the cliffs at Newhaven, on the Sussex coast, a very curious series of changes is going on. A stratum of marl, containing decomposing pyrites, lies upon the chalk, which gives rise

The flints or pebbles composing the *breccia* (No. 3) are characterized by their green and ferruginous crusts.

This appearance is so peculiar, that it frequently serves to identify the situations formerly occupied by the breccia, even where the stratum itself has been broken up and destroyed. These pebbles are scattered over the ploughed lands on the summits and slopes of the Downs, near Tarring, Piddinghoe, Falmer, Stanmer, Bormer, and many other places in the vicinity of Lewes. I have also detected them in the alluvium of the in-

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to the formation of sulphate of alumine: this is decomposed by the chalk; and aluminous earth, selenite, and oxide of iron are the results." (*Manual of Chemistry*, 3 Vols. 8vo. 1821. Vol. iii. p. 312.)

In the *Annals of Philosophy* for August, 1820, Mr. Cooper, of the Strand, gives a description of an aluminous chalybeate spring, situated on the coast between Newhaven and Rottingdean. The precise situation of this spring is not mentioned, and my brother and myself have searched for it in vain. I can therefore add nothing to the following extract from Mr. Cooper's letter:

Description of an Aluminous Chalybeate Spring *on the coast of Sussex*, (*from the Annals of Philosophy, Aug.* 1819. Art. 11, No. 80, page 148.)

" Dear Sir, 89, *Strand, July*, 1819.

" I was requested to examine a bottle of water which was brought to me from the coast of Sussex, between Newhaven and Rottingdean; and although the quantity I had was small, (being only about a wine quart) yet there was sufficient to ascertain its general nature and characters, without regarding the quantities of its component parts.

" The spring is situated, as I understand, about midway between Newhaven and Rottingdean, at an elevation of about 15 or 16 feet above the level of the sea at high water mark. It issues from between the cliffs or fissures of the chalk in small streams, and these when united pour forth from 20 to 25 gallons in the hour. The chalk about the place is every where tinged with an ochreous deposit. Its temperature as it issues is 65° Fahr. and remains constantly the same. When I received it, there was a deposit of a brownish colour, which proved on examination to be oxide of iron. Its specific gravity, at the temperature of 60° Fahr. was 1·076: it is slightly acidulous, changing the colour of litmus paper both before and after boiling, by which operation it deposits a further portion of oxide of iron, and also a little lime. Reagents show it to contain the following substances in solution:

Oxide of iron,
Alumina,
Muriatic acid,
Sulphuric acid,
Lime,
Carbonic acid,
Soda.

" This last substance I will not be quite certain of; but I expect shortly to be able to make a more perfect analysis, and to give a better account of its situation, which is of some importance, as I expect it is not far distant from the spot where the native alumina or subsulphate is found.

I am, &c.
John Thomas Cooper."

" *To Dr. Thompson.*"

terior of the country. Waterworn fragments of the breccia occasionally occur in similar situations; some of considerable magnitude may be observed lying bare in the fields near Brighton church, Goldstone-bottom, and Falmer-hill*.

The selenites or crystallized gypsum (of No. 5) occurs in flattish crystals, from six to eight inches long, which are generally in the form of oblique parallelopipeds, or of rhomboidal prisms. The fibrous gypsum is deposited in veins in the marl; the foliated variety occurs in large tabular masses, composed of thin laminæ, and is frequently coated with a coaly substance.

The *surturbrand* or *coal* (No. 6) appears to be analogous to that of the Paris Basin, Corfe castle, and Alum bay: it also resembles the surturbrand of Iceland; some specimens are exactly similar to the Bovey coal.

Rolled masses of this substance are frequently found on the shore at Brighton, and were formerly so abundant as to be used for fuel by the poorer inhabitants†. They are provincially called *strombolo*, a corruption of *strom-bollen, stream,* or *tide balls;* the name given them by the Flemings, who formerly settled in that town.

The use of this substance was prohibited, on account of the very offensive smell emitted during its combustion. It was employed by the late Dr. Russell as a fumigation in certain glandular complaints, and it is said with decided benefit.

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* The boulders of this breccia, like those of the siliceous sandstone, were used in distant ages as sepulchral stones. Beneath one of those, near Brighton church, an urn of high antiquity, containing human bones and ashes, was discovered by the late Rev. J. Douglass, F.A.S.

An immense block of this kind is situated in Hove parish, near the Shoreham road, and is vulgarly called Goldstone, "from the British word *col*, or holy-stone; it is evidently a tolmen of the British period. This stone is in a line to the south of Goldstone-bottom, at the end of which, close to the rise of the hill, is a dilapidated *cirque*, composed of large stones of the same kind. On the farm of Thomas Read Kemp, Esq. opposite Wick, are two dilapidated *kist vaens*, formed of similar materials; and on each side of the British trackway, leading to the *Devil's Dyke*, blocks of the same substance may also be observed." Extract of a letter from the late Rev. J. Douglass, to the Author, dated May, 1818.

† *Lee's History of Lewes and Brighthelmstone*, 8vo. 1795, p. 554.

It is difficult to imagine from whence so large a quantity of this substance could have been derived. The narrow layer at Castle Hill, is evidently too inconsiderable for the pur-

The organic remains found in these deposits are the following:

1. Wood.

A small block of wood, with the ligneous structure well preserved, has been discovered in the sand of the Diluvium (No. 11.)

2. Impressions and remains of leaves, Tab. viii. figs. 1, 2, 3, 4.

——————————— *Brit. Min.* tab. 500.

The specimens figured in Tab. viii. and in Mr. Sowerby's *Brit. Min.* were collected from the red marl (No. 7); but although considerable diligence has been used to add to their number, our researches have been unsuccessful, nor can we discover the precise spot from whence they were taken. They are peculiarly interesting, as they afford an example of leaves and shells imbedded in the same stone; an association but rarely observed.

The impressions in figs. 1, and 4, are thought to bear some resemblance to the larger foliage of *Platanus orientalis*. This opinion may probably be correct so far as regards the genus; but the characters of the leaves appear to be too imperfectly developed to admit of the species being identified.

Figs. 2, and 3, differ in some respects from those above described.

The upper beds of the "*Calcaire marin grossier*" of France, also contain vegetal impressions; but those represented in the "Essai sur la Géographie Minéralogique," Pl. 2. fig. 1. do not correspond with the fossils under consideration. The French specimens are supposed to belong to a species of *Nerium;* however this may be, it is obvious, that, like those of Newhaven, they cannot have belonged to any marine plant, although they are now imbedded in the midst of testaceous remains decidedly of marine origin*.

3. Mr. Webster mentions that H. Warburton, Esq. discovered in the marl at Newhaven, leaves precisely similar to those figured by

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pose; and no traces of it occur in any other part of the adjacent coast. The encroachments of the sea at Brighton are well known to have been very extensive within the few last centuries: is it probable that a bed of surturbrand formerly existed in the strata that have been swept away? or was the layer at Castle Hill, at that period, sufficiently extensive? was it washed from the opposite coast of France? or from Alum bay, in the Isle of Wight?

* *Essai Min. Géograph.* p. 126.

Cuvier, "and also a fruit of a species of palm, with the vegetable fibres quite distinct*."

4. The casts of shells in the specimens figured, belong to the genera *cerithium, unio,* and *cyclas;* the species of the latter resembles the Linnean *Mactra solida,* or *subtruncata,* which is also found abundantly with *cerithia,* in the blue clay at Woolwich †.

5. Cerithium *funatum.* Tab. xvii. fig. 4.

A conical elongated shell, with two obtuse, crenulated, transverse ridges on each volution.

It consists of ten or eleven whorls, and is seldom found perfect. It occurs in immense quantities in the blue clay (No. 8), and is sparingly distributed in the *oyster-bed* (No. 10), and in the *red marl* (No. 7).

6. Cerithium *melanoides.* Tab. xvii. fig. 3.

Turreted, whorls convex, longitudinally undulated, transversely carinated; carinæ tuberculated.

This elegant species is found in the same stratum with the above, but is easily distinguished by the sharp, tubercular, carinated ridges with which it is ornamented, and the longitudinal depressions between the tubercles. It is comparatively rare.

7. Helix? Tab. xviii. figs. 19, 20.

The delicate little shell, figured in the plate referred to, was found by Col. Birch, of Bath, in the blue clay (No. 8), of Castle-Hill. The mouth is filled with clay, and the specimen is too fragile to permit its removal; the surface is perfectly smooth; the spire elevated; the volutions are three in number. It has much the appearance of a fresh-water shell.

8. Cytherea *scutellaria?* (of Webster). Tab. xxv. fig. 2.

This fossil is from the blue clay (No. 9), which is almost entirely composed of broken bivalves, apparently of the genera *cytherea* and *cyclas.* A perfect example is exceedingly rare, and I have not yet been so fortunate as to discover one; the shell represented being the most entire of any in my possession.

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* *Geolog. Trans.* Vol. ii. p. 191.

† *British Mineralogy,* Vol. iv. p. 185.

I believe it is this bivalve that Mr. Webster has designated by the name of *Cytherea scutellaria.* It very nearly resembles the "cythérée bombée" of Lamarck, "des marnes superieures du gypse[*]."

9. A species of *cyrênê?*

This shell was also found in the blue clay (No. 9), and is remarkable from its being the only decided instance of a fresh-water shell that has been discovered in that deposit[†].

10. Ostrea.

The bed, No. 10, consists principally of a broad, flat species of oyster, presenting nothing peculiar in its form or appearance. Another species is sometimes found, in which the upper valve is nearly flat, and the lower one very convex; this shell is precisely similar to a specimen in Mr. Parkinson's cabinet, marked *ostrea vesicularis*[‡].

11. Tooth of the Squalus *mustelus.*

This specimen is from the blue clay (No. 8), and perfectly resembles the teeth of the recent fish.

Of the strata above enumerated, Nos. 8, 9, 10, are considered by Professor Buckland, as analogous to the plastic clay beds of Woolwich, (Nos. 7, 8. Pl. xiii. *Geolog. Trans.* vol. iv.) which contain also the same species of *cerithium* and *cyclas.*

No. 4 of Castle Hill, is the ash coloured sand of Woolwich, in diminished thickness. The *breccia*, No. 3, corresponds with the Reading oyster bed, which "though inconsiderable in thickness, seems constantly to occur immediately above the chalk; although organic remains have been noticed in it only at Reading*."

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[*] *Géographie Minéralogique*, p. 276, Pl. ii. fig. 7.

[†] The fossil in question was submitted to the examination of Mr. G. B. Sowerby, who favoured me with the following observations.

"The specimen you have sent me has every character of a *cyrênê*, and of being a *fresh-water* bivalve. I would, however, suggest the necessity of extreme caution in noting the stratum from which it was obtained. If from the *plastic clay*, it is the first that I have seen *decidedly* from that formation, of a *fresh water* origin; all the fossils from the *London* and *plastic clay* being *marine.* This shell, too, bears considerable resemblance to some from Woolwich; as well as to a species that occurs abundantly in the stratum of mélange between the two fresh water beds at Headen hill, in the Isle of Wight."

[‡] In a recent communication from M. Brongniart, that distinguished geologist questions the propriety of this appropriation. He remarks, that in the environs of Paris, the *ostrea vesicularis* of Lamarck is confined to the upper, or flinty chalk. It is therefore probable, that the English fossil belongs to a different species.

Between Castle Hill and Seaford, a flat alluvial tract intervenes, through which the Ouse flows into the British Channel. To the east of this marshy plain, the perpendicular slopes in which the Downs terminate, are covered with a cap of fawn coloured and greenish sand, with rolled blocks of chalk, and flint pebbles. An excavation on the side of the hill, near the road leading from Newhaven to Seaford, exhibits a good section of these deposits. The rolled pebbles and sand, occupy about fifteen feet of the upper part of the bank, and lie in a hollow or basin of chalk rubble; and wherever the chalk is accessible to observation along this margin of the Downs, it is invariably in a broken and ruinous state.

At Chimting Castle, about half a mile to the east of Seaford, the upper part of the cliffs is composed of a bed of sand, about fifty feet thick. Here a stratum of the ferruginous breccia, previously mentioned, is seen in situ, lying beneath the sand, and immediately upon the chalk. The sand is of a fawn colour, passing into olive green; it contains numerous irregular veins, and concretions of mammillated ironstone. The pudding-stone, or breccia, is precisely similar to that of Castle Hill, with which, there can be no doubt, it was once continuous. The flints that compose it, present the same characters; some being rolled, others angular, and all of them either of a dark green or yellow colour externally. The bed of breccia, in some places, is nearly four feet thick. These deposits extend eastward about half a mile, and disappear near the Signal House; they dip to the west at an angle of from 10° to 20°.

Eastward of this place, the chalk has only a covering of ochraceous clay, and vegetable mould, and, with the exception of the blocks of breccia at Brighton, &c. previously alluded to, and a few insular patches of olive green sand in hollows of the chalk at Piddinghoe, I am not aware of the existence of any other decided examples of the Plastic clay, in the south-eastern part of Sussex.

In the western division of the county, Professor Buckland observed a red variety of Plastic clay, in a small valley, at the village of Binstead, three miles west of Arundel; and also on the declivity of the hill by which the Binstead and Chichester road descends into Arundel.

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* Professor Buckland on the Plastic Clay, *Geolog. Trans.* Vol. iv.

The country around Chichester has a foundation of chalk, with a subsoil of fine red gravel, and pebbles, mixed with sand, loam, and chalk rubble. Furrows and wells in the chalk, filled with these materials, are commonly observable in the quarries near that city.

On the opposite coast of France, strata corresponding with those of Castle Hill, and Chimting Castle, occupy the same relative position.

In the perpendicular cliffs, under the light-house of St. Margaret, to the west of Dieppe, the following beds occur:—

1. Chalk.
2. Sand and sandstone in thick beds, containing concretions of the same substances.
3. Plastic clay, impure, and containing lignite much charged with pyrites. Also oysters, cerithia, &c. both in beds, and irregularly disseminated.
4. Alluvium*.

These deposits M. Brongniart considers as identical with the beds of the Plastic clay formation in many other parts of France; particularly at Marly, and in the Soissonnois, where similar organic remains occupy strata disposed in the same manner, and identical with those near Dieppe.

In the preceding sketch of the strata of the *Plastic clay* of Sussex, the geologist will immediately recognize the usual characters of that formation, which, "viewed on an extended scale, is composed of an indefinite number of sand, clay, and pebble beds, irregularly alternating. The distribution of the organic remains, like the alternation of the strata, being exceedingly variable; sometimes they occupy the clay; at other times the sand or pebbles; and very frequently are altogether wanting in them both†."

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* Professor Buckland on the Plastic Clay Formation, *Geolog. Trans.* Vol. iv. p. 295.

† *Geological Transactions,* Vol. iv. loc. cit.

XVII.

§. III. II. LONDON CLAY.

This formation consists chiefly of a dark blue clay, which in some localities includes beds of grey limestone and sandstone.

Both the clay and limestone occur in Sussex; the former constitutes the flat maritime district of the south-western part of the county; the latter composes groups of rocks on the coast.

Blue Clay.

This deposit forms the line of coast from Worthing to Christchurch in Hampshire, extending from the latter place inland, by Ringwood, Romsey, and Fareham; and passing a mile or two south of Chichester, terminates near Worthing, from whence to Brighton, the surface of the chalk near the coast, is covered with beds of loam, clay, brick earth, gravel, &c.*

In some parts of its course in Sussex, it contains an abundance of the organic remains for which it is so remarkable. Emsworth and Stubbington, on the confines of the county, have been noticed by Mr. Webster, as abounding in fossil shells. Bracklesham, near Selsea, is equally productive; and if I may judge from the liberal contributions of my friends, will almost rival the celebrated cliffs of Hordwell.

On the coast westward of Selsea, near Thorney and Bracklesham, vast quantities of fossil shells are washed out of the clay and deposited on the shore, by the action of the waves, particularly after severe storms. This bed of clay is, however, only accessible at low water, and even then but for a very short period.

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* *Phillips' Geology*, p. 32, edit. 1822.

Below the beach at Bracklesham, in the parish of East Wittering, the clay envelopes the trunks, roots, and branches of trees*.

In the second volume of the Geological Transactions, Mr. Webster has enumerated the fossils discovered by him at Bracklesham. An interesting collection from that place, for which I am indebted to the kindness of Mr. Hawkins, has enabled me to add very considerably to their number.

ORGANIC REMAINS FROM THE BLUE CLAY OF BRACKLESHAM.

1. Trochus *agglutinans.* (Lamarck). *Foss. Hant.* Tab. i. figs. 4, 5†.

2. Scalaria *acuta.* *Min. Conch.* Tab. xvi. figs. 4, 5.

This very elegant shell seldom exceeds 0·7 inch in length. It is readily known by the transverse risings on the lower margin of the spire, and its acute, expanded, recurved ribs.

It is very seldom found in the cliffs of Hampshire; Mr. Hawkins is the first who has noticed it in Sussex.

3. Voluta *luctator.* *Min. Conch.* Tab. cxv. fig. 1.

4. —— *bicorona.* (Lamarck). *Foss. Hant.* fig. 68.

A specimen of this species was discovered by Mr. Rollo. It appears to be rare at Bracklesham, although very common at Hordwell.

5. Pyrula *bulbiformis.* *Foss. Hant.* fig. 54.

6. ——— (*murex pyrus* of Brander). *Foss. Hant.* figs. 52, 53.

7. Ampullaria *patula.* (Lamarck). *Foss. Hant.* figs. 57, 59.

8. Natica *similis.* *Min. Conch.* Tab. v.

9. Conus *dormitor.* (Brander). *Foss. Hant.* fig. 24.

10. Ancilla *aveniformis.* *Min. Conch.* Tab. xcix. figs. 1, 2.

Another species of Ancilla also occurs, which approaches in some respects to A. *turritella* (of Sowerby); and some mutilated specimens resemble *Bulla sopita* (of Brander).

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* I am favoured with this account by my excellent friend John Hawkins, Esq. F.R.S. &c. of Bignor Park. Vide his "Observations on the geological phenomena of Western Sussex," published in Dallaway's history of that division of the county, Vol. ii.

† Fossilia Hantoniensia collecta, et in Musæo Britannico deposita, a Gustavo Brander, Londini 1766. This work is much prized by collectors for the elegance and fidelity of the plates. It contains figures of more than one hundred and thirty fossils of the London clay.

11. Fusus *longævus*. *Min. Conch.* Tab. lxiii.

The specimens in my possession are very small, not exceeding three inches in length. There can however be no doubt of their belonging to this species.

12. Solarium *canaliculatum*. (Lamarck). *Foss. Hant.* figs. 7, 8.

This elegant little shell is about 0·3 inch in diameter. The spire is depressed, and deeply umbilicated. The volutions are subrotund, and spirally striated; the striæ crenulated; the outer margin of the wreaths acute; aperture round.

13. Melania *costellata*. (Lamarck). *Foss. Hant.* fig. 27.

14. ——— *sulcata*. *Min. Conch.* Tab. xxxix.

This is a fine spiral shell, sometimes attaining eight inches or more in length, having from thirteen to fifteen whorls. It is spirally striated, and has a sulcus, or groove, between each wreath.

15. Pleurotoma ——, fragments of an unknown species.

16. Turritella *multisulcata*. (Lamarck).

17. ——— *conoidea*. *Min. Conch.* Tab. li. figs. 1, 4.

18. ——— *elongata*. *Min. Conch.* Tab. li. fig. 2.

Pyritous casts of *Turritellæ* are very frequent.

19. Murex *argutus*. *Foss. Hant.* fig. 13.

20. Dentalium *entalis?*

These Dentalites bear a close resemblance to the recent species; but there are some doubts as to their identity.

21. Cerithium *giganteum*. *Min. Conch.* Tab. clxxxviii. fig. 2.

22. Nummulites *lævigata*. *Parkinson's Org. Rem.* Vol. iii. Pl. x. fig. 13.

These are small, circular, multilocular shells, nearly smooth, and slightly convex on both sides. M. Cuvier considers the Nummulites to be characteristic of the lower beds of the *Calcaire grossier*. "Elles se trouvent, toujours dans les parties les plus inférieures*."

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* *Geograph. Min.* p. 23.

23. Venericardia *planicosta*. *Min. Conch.* Tab. l.

This shell is one of the most elegant of the genus. It is frequently four or five inches wide; of an obliquely cordate form, and the surface is divided by longitudinal sulci into about twenty broad flat costæ. Specimens from Grignon, sent me by M. Brongniart, are precisely similar to the Sussex shells; and are only to be distinguished from them, by their peculiar whiteness.

24. Venericardia *squamosa?* (Lamarck).

25. Sanguinolaria *Hollowaysii*. *Min. Conch.* Tab. clix.

A thin, transversely ovate, elongated bivalve, having a striated surface. The anterior side is much wider than the posterior.

26. Venericardia *acuticosta?* (Lamarck).

This shell is 1 inch wide, and 0·8 inch long, with 20 acute longitudinal ribs; the inner margin dentated.

27. Pectunculus *pulvinatus*.

28. Cardium *semigranulatum*. *Min. Conch.* Tab. cxliv.

——— *asperulum?* of Lamarck.

29. Chama *plicata*. (Brander.) *Foss. Hant.* figs. 84, 85.

The Bracklesham specimens are much larger than Brander's figures; but in other respects the resemblance is complete. The upper valve is nearly flat, and marked concentrically by the lines of growth; the lower one is convex, and deeply furrowed by longitudinal sulci.

30. Chama *lamellosa*. (Lamarck). *Foss. Hant.* fig. 86.

This species is subrotund, the surface marked with transverse concentric sulci; the lower valve very convex. It was found by Mr. Rollo.

31. Crassatella *lamellosa*. (Lamarck). *Foss. Hant.* fig. 89.

An elegant equivalve shell, of an irregular ovate form, with numerous, transverse, undulating sulci; the anterior slope produced, and angular; the margin crenulated; collected by Mr. Rollo.

32. Ostrea. A shell of this genus, but too imperfect to admit of specification.

33. Palate of a fish of the ray kind resembling fig. 117. *Foss. Hant.*

34. Vertebra of a fish. *Foss. Hant.* fig. 109.

2. SANDSTONE, OR ARENACEOUS LIMESTONE OF BOGNOR.

The sandstone rocks of Bognor are the ruins of a deposit once very extensive, and which, even within the memory of man, formed a line of low cliffs along the coast; at present, a few groups of detached rocks, covered by the sea at high water, are all that remains, and the period is not far distant, when all traces of it will be swept away by the encroachments of the ocean. The lowermost part of the rocks is a dark grey limestone, in some instances passing into sandstone: the upper part is siliceous. The *Barn* rocks between Selsea and Bognor, the *Houndgate* and *Street* rocks on the west, and *Mixen* rocks on the south of Selsea, are portions of the same bed. The fossils enclosed in these strata are nearly similar to those which occur in the London clay.

These beds are decidedly analogous to the *Calcaire grossier* of Paris; the correspondence in their geognostic situation, and in the nature of their materials, and organic remains, sufficiently evince their identity*.

The sandstone is of a grey colour inclining to green; and varies considerably in hardness and composition. The shells are generally white and friable, consisting of a soft calcareous earth, but in a few instances occur in a good state of preservation. To my young friend and pupil Mr. Rollo, (nephew of the late Dr. Rollo, of Woolwich,) I am indebted for the following specimens collected by him in the summer of 1820.

ORGANIC REMAINS OF THE BOGNOR SANDSTONE.

1. Rostellaria.

2. Natica similis? *Min. Conch.* Tab. v.

The specimen figured by Mr. Sowerby is from Bognor, and was collected by Wm. Borrer, Esq. of Henfield.

3. Lingula *tenuis*. *Min. Conch.* Tab. xix. fig. 3.

A delicate minute shell, of a lanceolate form, the anterior end truncated. It is generally of a reddish brown colour, has a glossy surface, and very much resembles a detached scale of a fish.

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* *Geological Transactions*, Vol. ii. p. 208.

4. Vermicularia *Bognoriensis.*

Spiral, last volution much produced, inferior side deeply umbilicate.

The longest diameter is about 0·5 inch; the volutions are five or six in number; the produced part exceeding in length the longest diameter of the shell.

The great length of the straight portion of the tube, the height of the spire, and the depth of the concave or umbilicated side, appear to be the distinguishing characters of this species. The wreaths are nearly round and smooth. It is gregarious, and occurs very abundantly in some parts of the sandstone: a block in my possession, about four inches square, contains nearly twenty specimens lying in relief.

5. Pyrula ——. (Murex *pyrus* of Brander.) *Foss. Hant.* figs. 52, 53.

A fine cast of this species is the only example hitherto discovered.

6. Dentalium *planum.* *Min. Conch.* Tab. lxxix. fig. 1.

This species is scarcely an inch long; it is curved, and gently tapering; the surface is smooth, and the aperture round. It occurs in small groups, and is evidently gregarious.

7. Mya *intermedia.* *Min. Conch.* Tab. lxxvi. fig. 1.

The width of this shell is equal to twice its length, which is seldom more than 1·3 inch. The anterior side is expanded, and the shell possesses a flatness, which Mr. Sowerby considers as characteristic of the species. The surface is smooth, except where it is marked by the lines of increase.

8. Pinna *margaritacea* *. (Lamarck).

The usual mode in which this species occurs, is that of casts covered with the pearly coat of the shell; very rarely, the shell itself remains.

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* This species is described by Mr. Parkinson; (*Organic Remains,* Vol. iii. p. 165) and is figured by Burtin, (*Oryctographie de Bruxelles*), fig. B. Pl. xviii. as a *Jambonneau ou Pinne marine.*

Mr. Rollo found a small block of sandstone, containing the remains of eight individuals.

The specimens are from four to five inches long, the shell very thin, and possessing the striated structure observable in the recent species of the genus. The surface is almost smooth, with the exception of a few indistinct longitudinal ribs, that are decussated by gentle concentric depressions formed by the lines of increase.

9. Pectunculus *pulvinatus.* (Lamarck.)

This shell is very abundant; large masses of the limestone being almost wholly composed of it; a slab in my possession, about a foot square, contains upwards of fifty specimens. Considerable variety is observable in the form of the shells; some being transversely, and others obliquely obovate, and a few nearly orbicular. They are from 0·5 inch to 1·8 inch long, and are marked by numerous longitudinal striæ, crossed by fine transverse lines; the marks of increase are distant. The hinge teeth are from fourteen to sixteen in number, and the interior of the margin is finely serrated.

10. A small tricuspid tooth of a species of squalus.

11. Large ramose zoophytes; the specimens are in too imperfect a state to be particularized.

The following shells are enumerated by Mr. Webster, but were not observed by Mr. Rollo.

12. Calyptræa *trochiformis.* *Foss. Hant.* figs. 1, 2.
13. Ampullaria *patula.*
14. Serpula.
15. Modiola *elegans.* *Min. Conch.* Tab. ix. fig. 5.
16. Ostrea *edulis.*
17. Teredo *navalis.*

XVIII.

§ IV. ALLUVIAL FORMATIONS.

By this term are designated those accumulations of sand, clay, gravel, rounded flints, and other water-worn materials, that cover the surface of the regular formations, and are composed either of the detritus of the upper portions of the strata on which they repose, or of heaps of materials confusedly mixed together, transported from distant or more elevated regions. These beds are consequently as various as the strata from whence they are derived, and it is neither possible, nor necessary, to enumerate every difference in their appearance, and composition.

As monuments of the last revolutions that have swept over the face of the earth, their study becomes peculiarly interesting; for although most of them may be regarded as recent depositions, when compared with the formations previously examined, yet even the latest will be found to exhibit indisputable evidence of a very remote origin.

The beds usually comprehended under the general name of *Alluvium* may be more properly separated into two divisions, viz.:

1. *Diluvium*, consisting of gravel, boulders, sand, &c. produced by causes no longer in action.

2. *Alluvium*, strictly so called, composed of the mud of rivers, deltas, the gravel of torrents, &c., the effect of causes which still continue in activity *.

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* "It will be convenient if geologists will consent to restrict the term *Diluvium* to the superficial gravel beds produced by the last universal deluge; and designate by the term *Alluvium*, those local accumulations that have been formed since that period by torrents, and rapid rivers, the bursting of alpine lakes, and similar minor causes, which operate daily, and partially, within the sphere of our own observation." *Professor Buckland, Geolog. Trans.* Vol. v. p. 533.

XIX.

§ IV. 12. DILUVIUM.

Irregular accumulations of clay, sand, and gravel, intermixed with broken chalk flints, are every where indiscriminately distributed over the surface of the country, and obscure the outcrops of the regular formations. These depositions are evidently composed of the ruin of the more ancient strata; and in all probability have been produced by that last catastrophe, by which the vallies have been excavated, and the hills moulded into their present form.

Of these deposits, the detritus of the chalk in a state of calcareous loam, broken flints, and gravel, constitute by far the most considerable portion; and so extensive is the destruction to which that formation has evidently been exposed, and so universally are its ruins distributed over the Weald of Sussex, as to warrant the conclusion, that it formerly extended very far beyond its present limits.

On the summits of the Downs, a layer of flints, slightly rolled, appears immediately beneath the turf, resting on an inconsiderable layer of chalk rubble. This bed contains rounded masses of chalk, crystallized carbonate of lime, ferruginous breccia, scoriaceous ironstone, a coarse grit containing angular fragments of quartz, and flattened oval pebbles of druid sandstone. The flints are more or less broken, have suffered but little from attrition, and are so abundant, as to form a constant supply for repairing the roads in the south-eastern part of the county. This bed has clearly been formed by the destruction of the upper portion of the chalk; and it is equally evident, that the cause which produced the ruin of the superior strata, was as transient, as it was powerful; since although the chalk in which the flints were imbedded has been entirely destroyed, the latter have sustained but very little injury.

Descending into the vallies, accumulations of chalk rubble and ochraceous clay, are again seen lying upon the basseting edges of the solid strata; and the slopes of the hills are generally composed of similar materials. Examples of this kind occur in almost every locality of the South Downs.

The gravel-pits (as they are called) of Barcombe, are part of a ridge of broken chalk flints, slightly rolled, resting upon a bed of ochraceous clay. The flints are of various shades of yellow, brown, and carnelian. The colour, which in all probability results partly from decomposition, and partly from an impregnation of metallic oxides, pervades the substance of the flint, but is much paler towards the centre than on the surface. These flints are not reduced to the state of pebbles, much less of gravel, but are merely broken, and the sharpness of their angles worn away.

At Isfield, Little Horsted, Barcombe, Wellingham, &c., the surface of the Weald clay, Iron sand, and Green sand, is covered with beds of gravel, composed of water-worn fragments of sandstone and ironstone, which in some instances are consolidated into a coarse aggregate, and are evidently the detritus of the upper layers of the Iron and Green sand formations. A considerable bed of it occurs in the parish of Barcombe, near the Anchor; at Hamsey, on the estate of the Rev. Geo. Shiffner; and at Wellingham, near the seat of Mr. John Rickman.

At Ringmer, and Laughton Place, a layer of loam and ochraceous clay is distributed over the surface of the Blue chalk marl, and frequently contains belemnites and other organic remains, that have been washed from the upper beds of that deposit. On the south side of the Downs, to the north-west of Brighton, beds of loam, marl, and clay, with interspersions of gravel, constitute a flat narrow tract of country that extends without interruption to Shoreham.

But the most considerable and important deposit of diluvial detritus in Sussex, is that forming the cliffs at Brighton; and which possesses characters so remarkable, as to require particular notice.

Brighton is situated on an immense accumulation of water-worn materials, which fills up a valley, or hollow, in the chalk. This diluvial deposit is bounded on the north-west by the South Downs; on the east it extends to Rottingdean, and is there terminated by the chalk; on the south it is washed by the sea, and forms a line of cliffs from 70 to 80 feet high; these exhibit a vertical section of the strata, and enable us to ascertain their nature and position.

A vertical section of the cliffs, about half a mile east of Brighton, is represented in Tab. iv. fig. 1. The lowermost bed is

1. The Upper, or flinty chalk; which constitutes about six or eight feet of the lower part of the cliff, and dipping southward, extends to an unknown distance into the sea. The continuation of the chalk behind the calcareous bed is marked "*former cliff*" in the sketch; and is introduced to shew the relative situation of the masses, but without any regard to proportion.

2. Bed of fine sand, from three to four feet.

3. *Shingle bed*, from five to eight feet.

4. *Calcareous bed*, formed of the ruin of the chalk strata, with an intermixture of clay; it is provincially termed *Coombe rock*;—from 50 to 60 feet.

The *chalk* presents its usual characters; and in various parts of its course is traversed by vertical and oblique veins of flint.

The *sand* is very fine, varying from pure white to a light reddish brown colour. It disappears about a mile to the east of Brighton, where the succeeding deposit lies immediately upon the surface of the chalk.

The *shingle* bed consists of pebbles, formed, like the present beach, of broken chalk flints rounded by attrition. It contains also water-worn blocks of granite, porphyry, slate, limestone, and druid sandstone. It occasionally envelopes masses of broken shells. The upper part of this bed is cemented together by calcareous spar, of a light yellow or amber colour, forming a kind of breccia of a very singular appearance*.

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* A specimen of this mineral is figured in *Sowerby's British Mineralogy*.

The *calcareous* bed is composed of broken chalk, with angular fragments of flint, imbedded in a calcareous mass of a yellowish colour, constituting a very hard and coarse conglomerate. It is not stratified, but is merely a confused heap of alluvial materials. It varies considerably in its appearance and composition, in different parts of its course. In the inferior portion of the mass, the chalk is reduced to the state of small grains, which gradually become larger in proportion to their height in the cliff; at length fragments of flint appear, and these increase in size and number as they approach the upper part of the bed, of which they constitute the most considerable portion. These flints are more or less broken, and resemble those of our ploughed lands that have been long exposed to the action of the atmosphere.

In some parts of the cliff irregular masses occur of an extraordinary hardness; these have been produced by an infiltration of crystallized carbonate of lime. Large blocks of this variety may be seen on the shore, opposite to the *New Steine*, where they have for years resisted the action of the waves.

This bed also contains water-worn blocks of druid sandstone, and ferruginous breccia, corresponding in every respect with those previously noticed in our description of the plastic clay formation. Small nodular masses, composed of carbonate of iron in lenticular crystals, interspersed with brown calcareous spar, have occasionally been found at the depth of ten or twelve feet from the summit of the cliff[*]. The only organic remains discovered in this deposit are the bones and teeth of the horse, and of the Asiatic elephant[†]; these occur but seldom, and are more or less water-worn[‡].

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[*] I am indebted to Mr. Langridge, of Brighton, for specimens of this substance, discovered in digging the foundation of a house on the east cliff.

[†] In the present month (April, 1822), a large molar tooth of the Asiatic elephant has been discovered in Lower Rock gardens, in a well 50 feet deep; by John Smith, Esq. Foreign Consul.

[‡] I have specimens of the teeth by favour of Mr. James Berry, architect, found in a well 50 yards inland, at the depth of 46 feet, in the *Coombe rock*, and immediately above a bed of shingle.

The wells in the lower part of the town pass through the calcareous bed, shingle, and sand, in succession; upon reaching the chalk, springs of good water burst forth, and these are said to be influenced by the tides[*].

Such are the leading features of these remarkable beds, in the immediate vicinity of Brighton; in their course eastward, towards Rottingdean, other characters are exhibited, which we shall now proceed to examine.

About a mile to the east of Brighton, vertical veins of tabular flint traverse the chalk in an oblique direction, and terminate with the chalk, immediately beneath the shingle bed (vide Tab. iv. fig. 2). To avoid repetition, it may be proper in this place to remark, that the veins of flint, so numerously distributed both horizontally and vertically throughout the chalk, are *invariably confined to that formation, and in no instance whatever appear either in the shingle bed, or in the calcareous bed above it*[†]. The shingle bed is perfectly horizontal, and contains boulders of chalk, druid sandstone, and ferruginous breccia. In the *Coombe rock*, the proportion of chalk is so great, that the cliff at a distance assumes the appearance of a regular stratum; but upon closer examination, it is evident that the chalk at some remote period has been broken, and displaced; and having fallen upon the shingle, previously to the formation of the calcareous bed, has subsequently been covered by that deposit.

In Tab. iv. fig. 2, the chalk traversed by oblique veins of flint, is seen

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The teeth are rounded by attrition, but in other respects have suffered no material change.

The story of human bones having been found in the "calcareous bed," is too apocryphal to require notice.

[*] "Some wells at Tetney (a village on the coast of Lincolnshire), that are sunk in the chalk, are also affected by the tide; the wells overflowing with a greater flux at the time of high water, and particularly at spring tides; shewing that the water in the chalk communicates with the sea." *Geolog. Trans.* Vol. iii. p. 394.

[†] An opinion having been expressed (by a gentleman well known in the scientific world), that the flint veins traverse not only the shingle bed, but also the calcareous deposit; and have been formed "subsequently to the accumulation of an alluvial bed, by the attrition of agitated water;" and that the cliffs at Brighton are to be regarded as "two very distinct chalk formations[*];" I carefully repeated my examination of the strata in question; but could not discover any appearance to support such an hypothesis.

[*] Vide *Royal Institution Journal*, No. 8, pp. 227, et seq. *Phillips' Outlines*, Edit. 1822, p. 106.

forming the base of the cliff. The shingle bed succeeds; and immediately above it, is a heap of chalk in a state of ruin; the latter is invested by the calcareous bed, of which the upper part of the cliff is composed. This appearance is curious, but the manner in which it has been produced is easily explained, by a reference to those natural operations that still continue in full activity on our coasts. Were a bed of calcareous rubble to be deposited over the ruins of the chalk cliffs that are scattered along the shore, a collection of materials would be formed, corresponding in every respect with those above described; and a vertical section would exhibit an appearance precisely similar; namely, a stratum of solid chalk at the base; then a layer of sand and of shingle; and lastly, a heap of displaced chalk, surrounded by calcareous diluvium. In corroboration of this opinion, it may also be remarked, that while in general, the variations observable in the colour and composition of the calcareous bed, are nearly horizontal, in the circumstances under discussion, they are no longer conformable to the subjacent deposit, but rise over the heaps of chalk rubble; as in Tab. iv. fig. 2. These interspersions of pure chalk are frequent in other parts of the bed, but the present example is one of the most remarkable.

Proceeding eastward, at the distance of two miles and a half from Brighton, the cliff is composed of the Upper chalk, to the extent of three hundred yards. This remarkable change in the structure of the cliff has evidently been occasioned, partly from the destruction of the diluvial deposits by the inroads of the sea, and partly from a projection of the chalk, which formed their ancient boundary; for there appears to have been but little correspondence in the sinuosities of the ancient and modern shores. An abrupt recess marks this alteration in the face of the cliff; and here the calcareous bed rises suddenly to the summit of the chalk, over which it is continued in a layer of inconsiderable thickness (vide Tab. v. fig. 1). The shingle bed, which at a short distance to the west contains large masses of chalk, here suffers a remarkable contraction, and is divided by thin seams of sand and fine rubble. At the curvature of the recess, the shingle diminishes very abruptly, and soon entirely disappears. Along the face of the chalk, slight traces of it are here and there perceptible, and in these situations, the vertical flint veins that traverse the cliff, *invariably pass behind, and are concealed from view*, by the insular patches of shingle.

The face of the chalk is remarkably even; it is not, however, vertical, but forms a precipitous slope. In the upper part, the chalk is much broken, and contains two horizontal veins of tabular flint; the inferior strata are more regular. It is particularly necessary for the reader to bear in mind, that although the chalk with its horizontal flint veins, (vide Tab. v. fig. 1), is *higher* than the insular portions of the shingle bed, it is not situated *perpendicularly above* them; the cliff, as before mentioned, forms an inclined plane, its summit receding considerably from the shore: consequently a vertical section would cut off all traces of the shingle*.

On the eastern extremity of the recess, the chalk is traversed by numerous veins of marl, but in other respects presents nothing worthy of observation. At the termination of the chalk, a bold projection of the cliff occurs, in which the shingle and calcareous bed appear in their usual position and proportions.

Towards Rottingdean the cliffs increase in altitude, but the calcareous bed diminishes considerably in thickness, and wherever a vertical section is exposed, is seen lying upon the shingle, in contact with a sloping bank of broken chalk; the latter being evidently the ruin of the ancient chalk cliffs, the flints it contains presenting no appearance of having suffered either from attrition, or exposure.

To the west of Rottingdean, the cliffs are chiefly composed of the regular chalk strata, containing, as usual, horizontal beds of siliceous nodules, and veins of tabular flint. Veins of marl are also very numerous, and there is one of remarkable extent, which appears beneath the shingle, and extending in a horizontal direction to within a short distance of

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* It was probably from want of attention to this circumstance, that the respectable writer previously alluded to, was led to adopt the opinion, that the shingle bed was situated between two distinct beds of flinty chalk.

Rottingdean, (vide Tab. v. fig. 2), reappears on the eastern bank of the landing place (vide Tab. v. fig. 3).

In that portion of the cliffs we are now describing, the shingle terminates as represented in fig. 2. Tab. v.; and by a singular coincidence, a bed of flint nodules commences immediately beneath it, and pursuing a horizontal course in the chalk, resembles at a distance a continuation of that bed. It is scarcely necessary to observe, that this apparent identity is a mere illusion; a bed of *rounded pebbles lying upon* the chalk, cannot readily be mistaken for a stratum of *perfect chalk flints, still occupying the cavities in which they were originally formed.*

On the west side of the landing place at Rottingdean, the cliff is low, and its upper part occupied by a mass of chalk rubble, analogous in some of its characters to the calcareous bed, of which it may possibly be a continuation. It is strongly marked with undulating lines, of an ochraceous yellow colour. The chalk on both sides of the gap is more or less disturbed, and the veins of tabular flint are broken and contorted; this is remarkably the case with those on the eastern bank (vide fig. 3, Tab. v), in which the fragments of flint are detached from each other. The beach near this place contains semitranslucent pebbles of agate, and chalcedony, of a bluish grey colour. These are collected by visitors, and when cut and polished, are used for bracelets and other ornamental purposes: they are usually called "*Rottingdean pebbles.*"

In concluding this description of the cliffs between Brighton and Rottingdean, I would observe, in the words of Mr. Webster, "that it is impossible to view them, without immediately perceiving, that they do not owe their existence to original stratification, but are simply the section of an immense heap of fragments of chalk, and flints, mixed with clay and sand, the whole having, at some distant period, been subjected to the action of water, and deposited upon the solid chalk stratum."

It would be unjust to close this article, without acknowledging my obligations to Miss Sarah Godlee, of Lewes, for the elegant and accurate sketches of the strata, engraved in Tab. iv. and v.; and to Mr. Thomas

Hodgkin, of Brighton, for an interesting account of the principal phenomena above described; to the kind assistance of this gentleman, whose residence near the spot afforded him every facility for accurate observation, I hold myself particularly indebted.

ORGANIC REMAINS OF THE DILUVIAL DEPOSITS.

It is precisely in deposits of this kind, that is, in diluvial beds spread over the surface of plains, or accumulated in the bottoms of vallies, that the remains of quadrupeds have been discovered in various parts of England. In Sussex, however, these remains but very rarely occur; the bones and teeth of the horse, and of the elephant, being the only examples at present known.

Mr. Hawkins informs me, that about sixty years since, the bones of an elephant were dug up in Burton Park, near Arundel, but I have been unable to obtain any satisfactory account of the circumstances attending their discovery.

In the brick loam at Hove, near Brighton, a fragment of a bone resembling the femur, and a grinder of a large size, were found at the depth of about six feet; the tooth was decidedly that of the Asiatic elephant.

In the spring of last year, at Peppering, near Arundel, the bones, and several grinders of elephants, were found in a bed of gravel, on the estate of John Drewett, Esq. of Peppering, who kindly favoured me with the following remarks concerning them.

"The remains in question were found in a bed of gravelly loam, situated near the foot of the Downs, and reposing upon the chalk, at an elevation of about eighty feet above the level of the Arun. They were lying very superficially, the first fragment of bone that attracted our notice being scarcely three feet beneath the surface. The specimens collected consist of a tusk, four grinders, and several fragments of other bones, apparently portions of the skull; the body appeared to lie beneath a bank of earth of considerable thickness, and could not have been removed without much labour. The tusk was lying upon its convex part, and notwithstanding every precaution, broke into several pieces, upon our attempting to remove it. It measured four feet and a half long, and from twenty-two to twenty-four inches in circumference; but neither the base nor point were perfect. The largest grinder of the lower jaw weighed six pounds four ounces; its upper surface being three inches and a half wide, and seven inches long; one of the molares of the upper jaw was broken in two, and the pieces detached from each other."

The grinders and bones of the elephant, and horse, occur in the calcareous bed at Brighton, as previously mentioned.

The antlers and bones of the red deer are said to have been discovered in a bed of loam, in sinking a well near the barracks, a mile to the north-east of Brighton; but much confidence cannot be placed in the correctness of the information.

XX.

§ IV. 13. ALLUVIUM.

UNDER this name are included,

1. Marsh land, composed of blue clay, silt, &c. produced by rivers.
2. Peat, and subterranean forests.
3. Calcareous tufa, deposited by springs.
4. Sand, and comminuted shells, on the coast, and drifted inland.

These depositions are clearly the effect of local causes which still continue in operation, and appear to have proceeded with but little modification, from the period when our continents assumed their present form[*].

In Sussex, the marsh lands (No. 1), which from the flatness of their surface, have received the provincial name of "levels," constitute several extensive tracts, partially filling up vallies in the older formations. They perfectly correspond in the nature of their materials, and for the most part have a river flowing through them. A description of those of Lewes will serve to convey a correct idea of the whole.

LEWES LEVELS, have already been noticed as constituting a flat marshy tract, through which the river Ouse winds its way to the British Channel. Tradition, ancient records, and the names of several hamlets[†] situated upon its borders, lead to the opinion, that in distant ages, it was covered either by an arm of the sea, or an inland marine lake, which extended up the country far beyond the town of Lewes; the site of the cliff being buried beneath its waters. During the last century, and before the present improved state of the navigation of the Ouse, the levels were annually exposed to extensive inundations, from the overflowing of the banks of the river; the *rhies* and other eminences, forming islands in the midst of the lake.

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[*] *Phillips' Geology*, (Edit. 1822), p. 4.

[†] Hamsey, Landport, &c.

A section of this alluvial deposit exposes,

1. Pipe clay; the detritus of the chalk marl upon which it reposes,	1 foot.
2. Silt, or blue clay, with marine and fresh water shells; from	5 to 25 feet.
3. Impure peat, with trunks of trees,	5 feet.
4. Vegetable mould,	1 foot.

Interspersions of white sand, gravel, and chalk rubble, also occur in various places.

The pipe clay is sufficiently plastic for the usual purposes to which that substance is applied, and is evidently the detritus of the chalk marl.

The *silt* varies in thickness from three to twenty-five, and in some instances, to thirty feet. The lower part of the bed contains marine shells; the upper, fresh water shells; but in the intermediate layers, both kinds are indiscriminately mixed together. The shells correspond with the recent testaceæ of the adjacent river, and sea; and I believe, are common in other alluvial depositions near the coast. I am indebted to William Wood, Esq. F.R.S. &c. (of the Strand), for the following determination of their characters.

Shells from the Silt of Lewes Levels.

Marine.

1. Turbo *ulva.*
2. Tellina *solidula.*
3. Cardium *edule.*
4. Mactra *Listeri.*

Fresh water.

1. Helix *planorbis.* (Planorbis of Lamarck).
2. Helix *cornea.* (Planorbis *cornea* of Lamarck).
3. Helix *stagnalis.* (Lymnea of Lamarck).
4. Helix *palustris.*
5. —— *limosa.*
6. —— *putris.*
7. —— *tentaculata.*
8. Turbo *fontinalis.*
9. Tellina *cornea.* (Cyclas *cornea* of Lamarck).

The peat consists of the remains of rushes, flags, and the foliage of various kinds of plants that affect a marshy soil; it occasionally contains the trunks of large trees[*].

The alluvial deposits above described, are clearly of very remote antiquity, as is evident from the superficial situation in which ancient coins, &c. have been found. On the west side of Glynd bridge, a paved Roman causeway was discovered lying about three feet beneath the turf, upon a bed of silt twenty feet thick[†]. And in forming the new road across the levels from Ranscombe to Beddingham, a coin of *Domitian* was found immediately beneath the turf. From these circumstances we may infer, that the formation of the levels was antecedent to the Roman advent; and that since that period, they have not received any material addition.

They also afford an interesting example of the gradual conversion of an extensive basin of salt water, into a fresh water lake[*], and of the transition of the latter into a narrow river, which now flows through a fertile tract formed of the detritus of other strata, brought in remote ages from the interior of the country, and deposited in a valley of the chalk formation.

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[*] "In widening the bed of the Ouse, trees, each containing a load of timber, were discovered." *Cook's Topography of Sussex.*

[†] A large brass of *Antoninus Pius* was found near it.

2. SUBTERRANEAN FORESTS.

The occurrence of large trees beneath the surface of the earth, with their leaves, roots, and even fruits, more or less preserved, attracted the attention of philosophers at a very early period. These subterranean forests have been noticed in almost every part of England, and various conjectures offered in explanation of the catastrophes by which they have been overwhelmed. The subject has been ably treated by Mr. Parkinson[†], to whose work the reader is referred for an interesting account of the most remarkable examples.

The trees are chiefly oak, hazel, fir, birch, yew, willow, and ash; in short, almost every kind that is indigenous to this island occasionally occurs. The trunks, branches, &c., are dyed throughout of a deep ebony colour; the wood is firm and heavy, and sometimes sufficiently sound for domestic use; in Yorkshire it is employed in the construction of houses. Several accumulations of this kind have been discovered on the coast of Sussex, occupying low alluvial tracts, that are still subject to periodical inundations.

At Felpham, near Bognor, on the 25th of October, 1799, a submarine forest was laid bare by a north-east hurricane. It was situated about five feet beneath the surface; but neither its thickness nor extent could be ascertained; notwithstanding, there can be no doubt, that it pervades the

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[*] This conclusion naturally results from the occurrence of marine shells in the lower beds only, and of fresh water in the upper, the two being intermixed in the intermediate layers; since the experiments of M. Beaudant have shewn, that if fresh water mollusca be suddenly introduced into sea water, they die in a very short time; but if the fresh water is very gradually impregnated with salt, they will live in it when of the strength of sea water without any injury: the same experiments repeated on fresh water mollusca gave similar results. Vide *Annal. de Chim. et Physique*, ii. 32.

[†] *Organic Remains*, Vol. i. p. 62, et seq.

Felpham levels, probably as far as the village of Barnham. Large portions of the trunks of trees, and heaps of reeds, oak-leaves, &c., matted together, were observed, permeated throughout with a bituminous stain. This storm also exposed on the strand, at low water, upwards of forty large oak trees, lying with their heads toward the south-east. The body of the largest measured four feet in diameter, the wood was extremely black, and emitted a strong sulphureous smell during combustion. Trees of this kind have often been observed by the inhabitants of Bognor after a north-east storm, and doubtless, may again be witnessed under similar circumstances by any curious inquirer*.

In Pevensey levels the trunks of large trees have often been observed, imbedded in a mass of decayed vegetables. The substratum is an inferior peat, with an intermixture of sand, reposing upon a thick bed of blue alluvial clay, containing marine shells of the same species as those that occur in Lewes levels. In that division of the marsh called *Hoo Levels*, a submarine forest was discovered a few years since. It lies in the western extremity of Bexhill parish, just above low water mark, adjacent to a manor farm of the Duke of Dorset, called *Conden*, nearly midway between Hastings and Eastbourne. The following description, from an anonymous correspondent, was published in the Gentleman's Magazine for 17—.

" In this place, there are the remains of 200 or more trees, which are firmly rooted to the soil, now become sand, and still retain their perpendicularity, and original position. Some of the trees are four or five feet above the surface, others have been cut down, or rather I conjecture worn away by the continued flux and reflux of the water. The ramifications, &c. of the roots are very perfect. The trees are of the same species as those of which our Sussex woods are composed, being principally oak and birch. At high water this spot is covered by the sea to the depth of ten or twelve feet; so that it is evident, that the earth must here have experienced some grand convulsion, as it is utterly impossible, under present circumstances, that any other than marine vegetation could thrive or even exist there.

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* Communicated by the late Rev. J. Douglas, F.A.S. of Preston.

"The adjacent country, inland, is a marsh from which the sea has been expelled, and is now kept out with great difficulty, and at a vast expense, and there is no woodland nearer than four miles, on the hill adjoining these levels."

The marsh called the Wish, near Eastbourne, chiefly consists of peat, of the same character as that of Pevensey, containing leaves, nuts, branches of trees, &c., and the bones of ruminants[*]: and at Isfield, in sinking the well near the paper-mill, a bed of similar materials was passed through; it is nearly 20 feet thick, and contains oak-leaves, nuts, branches of trees, &c.

3. Calcareous tufa, deposited by springs flowing through limestone strata, &c.

The deposition of calcareous earth from water flowing through beds of limestone, is a fact so well known as to require but little comment.

Springs of this kind occur in many parts of England, particularly in Derbyshire, where the incrustations they form are generally considered as petrifactions, although certainly having no claim to that title. The chemical changes which give rise to the phenomena in question admit of an easy explanation.

At the temperature of 60°, lime is soluble in 700 times its weight of water; and if to this solution a small portion of carbonic acid be added, a carbonate of lime is formed, and precipitated in an insoluble state[†]. If however the carbonic acid be in such quantity as to supersaturate the lime, it is again rendered soluble in water, and it is thus that carbonate of lime, held in solution by an excess of fixed air, not in actual combination with the lime, but contained in the water, and acting as a menstruum, is commonly found in all waters. Hence it is obvious, that a deposition of carbonate of lime from water, may be occasioned either from an absorption of carbonic acid, or from the loss of that portion which exists in excess.

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[*] In 1817 Thomas Smith, Esq. F.R.S., discovered in this alluvial bed the bones of a species of *Bos*.

[†] *Organic Remains*, Vol. i. p. 373.

The only incrusting spring that occurs in Sussex, has its source in the beds of limestone of the iron sand formation*. It is situated in a wood at Pounceford†, between Heathfield and Burwash. It forms an inconsiderable cascade over a rock of sandstone, and pursuing a tortuous course, deposits carbonate of lime on every extraneous body that lies in its channel; converting the mosses and other vegetables within reach of its waters, into masses of calcareous tufa. The specimens in my possession consist of incrustations of mosses, small branches of trees, leaves, &c.: some of them are composed of a porous friable calcareous earth; and others of a compact carbonate of lime of a subcrystalline structure, perfectly resembling the tufaceous depositions of Derbyshire. When recently collected, the moss on the surface was green and flourishing, and had evidently continued to vegetate although the roots, &c. were completely imbedded in the stone.

I have not been able to obtain any of the water for analysis; but it is evidently possessed of very considerable lapidescent powers, and might doubtless be applied to the same ingenious purposes as the waters of Tivoli, and the baths of St. Phillip, in Tuscany‡.

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* The existence of an incrusting spring in Sussex, was first made known to me by Mr. Daniel King of Lewes.

† Pounceford is the name of a farm in the possession of Mr. Edward Simes; in passing from Heathfield to Burwash, it lies to the right of the road, and may readily be found by enquiring of the keeper of the turnpike gate.

‡ At the baths of St. Phillip in Tuscany, a manufactory is established, where casts of medals and bas-reliefs are formed of calcareous tufa. The water is propelled from a considerable height into a large vessel, and being interrupted in its fall by a wooden cross, is separated into a fine spray and dashed against the moulds of the medals, which are placed round the sides of the vessel; by this means excellent impressions are produced. Vide *Org. Rem.* Vol. i. p. 363.

The waters of the Ouse also contain a considerable proportion of calcareous earth. A wooden pipe which had for several years been used for the conveyance of water from the paper-mill at Lewes, had its interior coated with a very compact carbonate of lime, nearly 0·4 inch thick.

4. Sand and comminuted shells on the coast, &c.

Under this head, I shall merely notice the low bank near the entrance of Shoreham harbour. It is about 20 feet high, and consists of clay and marl, resting upon a bed of sand that contains the remains of shells in a very fragile and mutilated state; they appear to be of the same species as those which inhabit the adjoining sea*.

Present effects of the Ocean.

Having examined the various accumulations of mineral substances that are worthy of notice in the district comprehended in the present volume, and described the numerous organic remains distributed in the respective deposits, it now only remains to investigate the nature of those changes which are still produced by that element, of whose powerful effects we have seen such unequivocal manifestations. But the present operation of the sea, seems to be wholly incapable of producing the important changes that have formerly taken place, and on the Sussex coast they are restricted to a gradual, but constant destruction, of the strata which compose its shores.

The encroachments of the sea along the coast of Sussex, have continued incessantly, from time immemorial; and when so considerable as to have occasioned sudden inundations, or overwhelmed fertile or inhabited tracts, have been noticed in our historical records. In the "*Taxatio Ecclesiastica Angliæ et Walliæ, auctoritate P. Nicholas*, (A.D. 1292), and *Nonarum inquisitiones in curia scaccarii*, (A.D. 1340), the following notices occur, of the losses sustained by the action of the sea, between the years 1260 and 1340; a period of only eighty years†.

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* On the authority of Thomas Smith, Esq. F.R.S. of London.

† I was favoured with this notice by the late Thomas Woollgar, Esq. of Lewes.

At *Pett*, marsh land overflowed by the sea; the tithes of which were valued at two marks per annum.

Iklesham and *Ryngermersh*, lands of which the tithes were 49*s*. 8*d*. per annum.

Thornye, 20 acres of arable, and 20 acres of pasturage.

Selseye, much arable land.

Felpham, 60 acres of land.

Middleton, 60 acres.

Brighthelmston, 40 acres.

Aldington, 40 acres.

Portslade, 60 acres.

Lancing, land, the tithes of which were 44*s*. 6*d*. per annum.

Siddlesham and *Westwythering*, much land.

Houve, 150 acres.

Terringe, land, the tithe valued at 6*s*. 8*d*. per annum.

Bernham, 40 acres.

Heas, 400 acres.

Brede, great part of the marsh called *Gabberghes*.

Salehurst and *Udimer*, land, the tithes of which were valued at 40*s*. per annum.

At Brighton, the inroads of the sea have been very extensive. In the year 1665, twenty-two tenements *under* the cliff had been destroyed, among which were twelve shops, and three cottages, with land adjoining them. At that period, there still remained *under the cliff*, 113 tenements; and the whole of these were overwhelmed in 1703 and 1705. Since that time, an ancient fort called the *Block House*, with the *Gun garden*, wall, and gates, have been completely swept away, not the slightest trace of their ruins having been perceptible for the last 50 years*.

At the present time, the whole line of coast, between the embouchure of the Arun, and Emsworth harbour, is visibly retreating, and the means adopted for its prevention, have hitherto been attended with but little success*.

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* *Lee's Hist. of Lewes and Brighton.*

The process by which this destruction of the coast is effected, is sufficiently obvious. By the incessant action of the waves the cliffs are undermined, and at length fall down, and cover the shore with their ruins. The softer parts of the strata, as chalk, marl, clay, &c., are rapidly disintegrated and washed away; while the flints, and more solid materials, are broken and rounded by the continual agitation of the water, and form those accumulations of sand and pebbles, that constitute the beach, and which serve, in some situations, to protect the land from farther encroachments. But when the cliffs are entirely composed of soft substances, their destruction is very rapid, unless artificial means are employed for their protection; and even these, in many instances, are but too frequently ineffectual.

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* *Dallaway's Western Sussex*, Vol. i. p. lv.

XXI.

CONCLUDING OBSERVATIONS.

In the preceding pages, it has been my object to convey a general idea of the mineralogical structure of Sussex, confining myself, so far as the nature of the enquiry would permit, to a plain statement of facts; and but seldom indulging in hypothetical discussions. I cannot, however, close this volume, without taking a more extended view of the subject; and, briefly noticing the principal phenomena that have been submitted to our examination, endeavour to point out the geological deductions that result from their investigation.

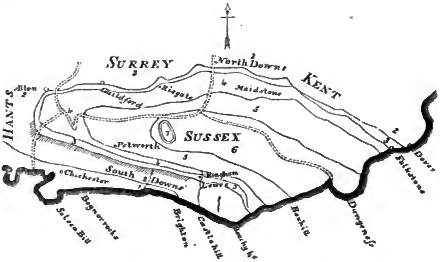
The chalk formation has been described as traversing the county in a direction nearly east and west, extending from Beachy Head, to near Midhurst; from whence it passes into Hampshire, and finally into Surrey and Kent, terminating in a range of lofty cliffs at Dover; thus forming a semi-elliptical chain of downs, that encloses an extensive district, composed of deposits more ancient than the chalk. On the south, and south-east, these strata are cut off by the British channel; and the southern margin of the chalk, is covered by the remains of the tertiary formations of the Isle of Wight basin.

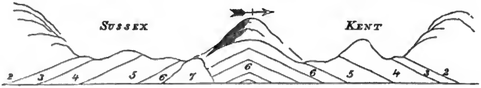
The area included by the chalk, has a range of hills belonging to the iron sand in the centre (the Forest Ridge); on each side of which the country gradually descends; the low district on the south-west, forming the Weald of Sussex; and that on the north-east, the Weald of Kent both being composed of the *weald clay* with its beds of shelly limestone.

In Kent, and Surrey, a range of hills formed by the *green sand*, intervenes between the *Weald*, and the foot of the Downs; but in the south-eastern part of Sussex, this deposit only constitutes a ridge of inconsiderable elevation.

Intermediate between the hills of the green sand and the chalk, is another valley, formed by the outcrops of the grey and blue chalk marl.

The annexed diagram and section, although possessing no pretension to accuracy of detail, will serve to render this description more intelligible.





The figures both in the plan and section, refer to the same deposits; the section is in the direction of a line drawn from the south of Sussex, to the north of Kent.

Explanation of the Plan, and Section.

1. Tertiary formations; Plastic clay of Newhaven.

2. 2. Chalk, constituting the South Downs of Sussex, the Surrey hills, and the North Downs of Kent.

3. 3. Grey and Blue chalk marl; at Ringmer, near Lewes, on the north of the South Downs; at Bletchingley in Surrey, and Folkstone in Kent, on the south side of the North Downs.

4. 4. Green sand, and cherty sandstone; at Eastbourne, south of Lewes, Ditchling, Haslemere, &c. in Sussex; near Godalming, Reigate, Nutfield, &c. in Surrey; Folkstone, and Hythe, in Kent.

5. 5. Weald clay, containing Sussex marble; Wealds of Surrey, Sussex, and Kent. The localities of the limestone in Sussex, are well known; in Surrey, it occurs at Red-hill, near Reigate; and in Kent, at Bethersden.

6. 6. Iron sand, with beds of bivalve limestone; forming the central range of hills on the boundary line of Kent, and Sussex.

7. Tilgate limestone, &c.

The plan shews the appearance of the strata on the surface, and the manner in which the various formations are disposed in regular succession within the area encircled by the chalk hills, arranging themselves round the central mass of Iron sand. Hence in the section from Newhaven to the Forest ridge, the deposits form a descending series, and are inclined towards the south; thus we have 1. the Plastic clay, 2. the Chalk, 3. the Blue chalk marl, 4. the Green sand, 5. the Weald clay, and 6. the Iron sand. But proceeding from the Forest ridge to Dover, they are passed over in an ascending order, and dip in a contrary direction; the Iron sand being the first, which is succeeded by the Weald clay, Green sand, Blue chalk marl, and Chalk.

Such is the geographical distribution of the strata in Surrey, Kent, and Sussex; and it is worthy of remark, that the formations on the opposite coast of France, are disposed in a similar manner, appearing like a continuation of the English beds. The escarpment of the French chalk describes a semicircle of about twelve miles radius, ranging around Boulogne as a centre; the southern extremity, on the coast near Etaples, corresponding with the termination of the Sussex Downs, at Beachy head; and the northern point at Calais, with that of the Kentish hills, at Dover. The included area contains beds of Green and Iron sand, but the greater part of the coast is composed of a calcareo-argillaceous formation, which underlies the sand last mentioned, and is considered by Professor Buckland as identical with the Oxford clay*.

This occurrence of the more ancient deposits, within a zone of chalk hills, is a problem exceedingly difficult of solution. From the appearance of the strata, as shewn in the plan and section, one might be almost led to suppose that the chalk, at some remote period, was continuous over the whole extent of country that now forms the counties alluded to, and that by some unknown catastrophe the central mass of chalk had been swept away, and the underlying deposits forced into their present situation. I do not, however, mean to insinuate, that such has actually been the case, but that the mode in which the strata are disposed presents such an appearance; for although (as an eminent geologist† has remarked), the truncated form of the escarpment of the chalk, evidently shews it to have once extended much farther than at present, still it would be highly rash to assume, that at any period it actually covered the whole space in which the inferior strata are denuded.

We shall now proceed to take a rapid sketch of the geological features of the several formations previously described, that their most important characters may be placed in a conspicuous point of view.

1. The Iron sand (p. 24), requires but a brief notice. It has been shewn to consist of various strata of sand and sandstone, including beds of ironstone (p. 28), shelly limestone (p. 30), and coal (p. 34). The limestone bears a considerable resemblance to the upper beds of the Purbeck, and is supposed to form the base, upon which the iron sand rests; yet there is reason to conclude that in some instances (p. 33), these deposits alternate. The shells enclosed in the limestone are wholly bivalve; some

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* Vide *Phillips' Geological Outlines*, p. 155. † Rev. W. D. Conybeare, *Phillips' Outlines*, p. 144.

resemble a species of Tellina, or Nucula, and others are supposed to belong to the genus Cyrênē; but whether they are of fresh water, or of marine origin, has not been satisfactorily determined.

The beds of Coal appear to be of very limited extent, and not likely to be sufficiently productive for economical purposes; their occurrence in such a situation, is, however, highly interesting to the geologist, and proves how much the existence of a deposit may depend upon local causes.

The organic remains are but few; traces of lignite or charred wood occur in the Iron sand; impressions of ferns, in the coal shale; and the casts and remains of bivalves, in the limestone.

2. Tilgate Limestone, &c. (p. 37). The strata designated by this name, are fully described in the body of the work; in this place it is only necessary to recapitulate the more important points. These deposits consist of thin beds of limestone and sandstone, which repose on Blue clay, and correspond in so many particulars with the Purbeck, that there is every reason to conclude they belong to that formation, and form a protrusion through the Iron sand by which they are surrounded (vide p. 58). They contain the remains of four or five species of vegetables, bearing a distant resemblance to recent tropical plants; nine or ten kinds of univalves and bivalves; several genera and species of fishes; three species of Turtle; and one or more gigantic animals of the lizard tribe, besides the bones, teeth, &c. of unknown animals, and perhaps of birds?

The remains of turtles, fishes, lizards, &c. occur in the Purbeck limestone, and the latter also corresponds in its chemical characters with that of Tilgate; it therefore appears unnecessary to renew the discussion on their supposed identity; and I shall only remark, that the fossils collected since the former part of this volume was written, serve to confirm the opinion therein advanced.

3. The Weald clay (p. 61), is characterized by the Sussex marble, which has commonly been supposed to be of fresh water origin, from the presumption, that the univalves it contains, are related to the recent Helix vivipara. But if the observations of Mr. G. B. Sowerby (vide

p. 67), are correct, (and his opinions on the subject are entitled to considerable deference), the hypothesis is untenable, since he believes that the shells in question possess neither the form nor structure of fresh water shells, but bear a close resemblance to a species of marine Turbo, allied to T. littoreus.

4. The Green sand (p. 69), with its beds and concretions of cherty sandstone, exhibits considerable variety, both in colour, and in the nature of its materials; it is, however, clearly identified with the Chlorite sand of Wiltshire by its organic remains, consisting of more than twenty kinds of fossil shells, most of which also occur in the same deposit in Devonshire and Wiltshire (p. 78). In some instances, the sandstone is strongly impregnated with bitumen (p. 76); in others, it contains fragments of petrified wood (p. 76)*.

5. The Blue chalk marl or Galt (p. 80), is a remarkable division of the chalk formation; and although not always present, yet wherever it does occur, maintains a striking uniformity, both in its mineralogical characters, and organic remains. It contains two or three species of Turbinolia; more than thirty kinds of testaceæ, which in most instances retain their shelly coverings in a beautiful state of preservation; five species of crustacea; and the scales, teeth, and vertebræ of fishes. Many of these fossils are peculiar to this deposit; namely, Turbinolia *Konigii*, Cirrus *plicatus*, Rostellaria *carinata*, Nautilus *inequalis*, Ammonites *splendens*, Hamites *attenuatus*, Nucula *pectinata*, Inoceramus *concentricus*, I. *sulcatus*, &c. and the crustacea.

The "Malin Rock" of western Sussex (p. 84), is evidently a continuation of the same bed, but somewhat altered in its characters by the influence of local causes.

6. The Grey chalk marl (p. 99), is co-extensive with the chalk, appearing throughout the county, on the inner edge of the escarpment of the Downs. Its organic remains are very numerous: those discovered

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* I have lately obtained several examples of fossil wood, from the Blue marl of Folkstone; and these so closely resemble the specimens found at Willingdon (described at page 76), that it is not improbable the latter may also belong to the lower beds of that formation.

in the vicinity of Lewes consist of wood, supposed Juli of the Larch, impressions of leaves, seven kinds of Zoophytes, several species of Echinites, upwards of fifty species of univalves and bivalves, and the remains of fishes, and crustacea. Of these, the *Scaphites*, *Turrilites*, *Hamites*, and the *supposed Juli*, are the most remarkable.

7. The Upper and Lower chalk (pp. 139 and 143), form the South Downs; their characters are too well known to require farther notice. They contain wood; impressions of supposed vegetable bodies; nearly thirty different kinds of Zoophytes; Star fish; fifteen species of Echinites; fifty species of univalves and bivalves; four species of crustacea; eighteen or more kinds of fishes; and the remains of a species of Monitor.

The strata comprised in the preceding sketch have manifestly, with but few exceptions, been formed by gradual deposition at the bottom of tranquil seas; the zoophytes and shell-fish having in all probability been enveloped, while living in their native beds. It is also evident, that these formations took place at periods sufficiently remote from each other, to allow of the consolidation of the inferior beds, before the upper ones were deposited; the line of separation being always distinctly marked, and the inhabitants of each formation, essentially differing from those contained in the strata either above, or below it.

8. The Tertiary formations have been described (p. 250), as lying in a basin, or hollow of the chalk; hence it is obvious, that the latter must have suffered considerable destruction subsequently to its consolidation; and the immense quantity of rolled chalk flints that occur in the Plastic and London clay, not only confirms that supposition, but also tends to prove that a considerable period must have intervened between the deposition of the chalk, and that of the strata under consideration. The beds comprehended in this division are the Druid sandstone, Plastic clay, and the London clay, and Sandstone.

The Druid sandstone (p. 253), appears to have anciently extended over a considerable portion of the English chalk, but now only occurs in the state of large boulders, which in most instances lie bare on the surface of the Downs. It is supposed that this sandstone did not form a continuous bed*, but was originally imbedded in sand, like the masses of "Whin stone" in western Sussex (vide p. 71). It is destitute of organic remains.

The Plastic clay (p. 256), consists of various beds of marl, sand, clay, and gravel; the lowermost constituting a ferruginous breccia, which lies immediately on the chalk. Castle hill, near Newhaven, and Chimting Castle east of Seaford, are the principal localities of these deposits in Sussex. This formation contains aluminite, crystallized sulphate of lime, surturbrand, wood, the impression of the foliage of a species of Platanus, fruit of the Palm? shells of the genera Cerithium, Helix, Mactra, Unio, Cytherea, Cyclas, and Ostrea; a shell which is supposed to be a fresh water bivalve (p. 264), and the teeth of a species of Shark.

The analogues of these beds appear on the opposite coast near Dieppe, where strata of sand, sandstone, and Plastic clay, are seen lying upon the chalk (p. 266)†.

The London clay (p. 267), is confined to the south-western part of the county. At Bracklesham it abounds in fossil shells, which exactly correspond with those of Hordwell in Hampshire, and Grignon near Paris; nearly forty species have been discovered.

The Limestone constitutes several groups of rocks, near Bognor and Selsea, (p. 271), and appears to be decidedly analogous to the *calcaire grossier* of Paris. It contains nearly twenty shells, peculiar to that deposit.

These Tertiary formations closely correspond with the lower beds of the Paris basin, and are without doubt detached portions of a series of strata, deposited under similar circumstances in that excavation of the English chalk, which geologists distinguish by the name of the Isle of Wight basin.

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* *Phillips' Outlines*, p. 14.

† That Great Britain was formerly united to the continent can scarcely be questioned; indeed, as Mr. Phillips observes, "the many remarkable points of agreement between the opposite coasts of France and England, render the supposition too reasonable to be ranked among mere hypotheses; their separation was, in all probability, occasioned by an irruption of the sea, which washed away the connecting mass." Vide *Geological Transactions*, Vol. v. p. 51.

Here then we have undeniable proofs of another deposition of regular strata, formed by a sea in a state of tranquillity, having been broken up and almost annihilated by some sudden and powerful catastrophe.

9. The Diluvian accumulations of sand, gravel, clay, pebbles, &c. (p. 275) promiscuously distributed over the surface of the country, and occasionally including the remains of Elephants, and other land quadrupeds, (p. 283), afford also conclusive evidence, that some general irruption of water has taken place subsequently to the deposition of the most recent of the regular strata.

To the same cause may likewise be ascribed, the present form and appearance of the surface of the earth, the rounded outlines of our hills, and the vallies, coombes, and sinuosities, by which they are intersected. For if there be any one fact thoroughly established by geological investigations, it is the circumstance, that our globe has been overwhelmed at a comparatively recent period, by the waters of a transient deluge*.

From the facts that have been presented to our notice, the following inferences naturally arise:

1*stly*. That the strata composing the county of Sussex, have been formed at different periods, by successive depositions at the bottom of tranquil seas †.

2*dly*. That the waters which deposited these formations were inhabited by shell-fish, zoophytes, fishes, &c., the greater part of which were not only essentially distinct from any that are known in a recent state, but many of them are confined to certain deposits.

3*dly*. That one of these formations (the Tilgate beds) contain the remains of shells, fishes, Palms, arborescent ferns, Turtles, gigantic Lizards, and unknown quadrupeds; an assemblage of organic remains, for which it is difficult to account, unless we suppose, that the bed in which they are enclosed was deposited by a river, or lake of fresh water.

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* Vide *Cuvier's Theory of the Earth*, (translated by Jameson), p. 171. *Mr. Greenough's Critical Examination of the First Principles of Geology*, p. 155. *Professor Buckland on the Quartz Rock, &c. Geological Transactions*, Vol. v. p. 544.

† The absence of all traces of land animals and vegetables in these beds, does not however appear to warrant the inference, that the former were not then in existence. For if we suppose that after the deposition of the Iron sand, the sea retired, and the surface of that formation became clothed with vegetation, and inhabited by animals; may it not be presumed, that if the approach of the next ocean was gradual, the advance and retrocession of its waves might destroy all traces of the land and its productions, before the water covered the surface to a sufficient depth, to allow of the tranquil deposition of the Weald clay? This remark equally applies to the other secondary formations.

4thly. That the chalk subsequently to its consolidation has suffered extensive destruction; the upper beds having been swept away, and extensive basins formed on its surface.

5thly. That the excavations, or basins of the chalk, have been filled up by a series of depositions, possessing very different characters to any that preceded them; and which in some places (Isle of Wight, Paris, &c.) consist of alternations of marine, and fresh water deposits.

6thly. That these newer depositions have also been broken up, and in a great measure destroyed, by an irruption of water in a state of violent commotion; a catastrophe to whose powerful agency the present form of the surface of the earth, and the accumulations of beds of gravel, sand, &c. are to be attributed.

7thly. That it is only among these last and newest deposits, the wrecks of ancient formations, that the remains of the Elephant, Deer, Horse, and other land quadrupeds, have hitherto been discovered.

Lastly, That the present effects of the ocean appear to be wholly inadequate to produce changes like those which have formerly taken place.

Hence it appears, that in the lapse of ages, the sea alternately encroaches on, and retreats from the land, and the districts it formerly occupied become the habitation of terrestrial animals and vegetables;——but other revolutions succeed, the sea returns to its ancient bed, and the countries from which it retires, are again fitted for the reception of their former inhabitants.

Thus, as an elegant writer* has remarked, to discover order and intelligence in scenes of apparent wildness and confusion, is the pleasing task of the geological enquirer, who recognizes in the changes which are continually taking place on the surface of the globe, a series of awful but necessary operations, by which the harmony, beauty, and integrity of the universe are maintained and perpetuated; and which must be regarded, not as symptoms of frailty or decay, but as wise provisions of the Supreme Cause, to ensure that circle of changes so essential to animal and vegetable existence.

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* Dr. Paris.

> Mysterious round! what skill, what force divine
> Deep felt in these appear!———
>
> * * * * * * * * * *
>
> Were every falt'ring tongue of man,
> Almighty Father! silent in thy praise,
> Thy works themselves would raise a general voice,
> Even in the depths of solitary wilds,
> By human foot untrod, proclaim thy power.

A Catalogue of the Organic Remains described in this Volume, to which Generic and Specific Names have been appropriated by the Author.

Zoophytes.

Alcyonium *pyriformis*.
Choanites, (a new genus, the name suggested by Mr. Konig).
——— *flexuosus*.
——— *Konigii*.
——— *subrotundus*.
Madrepora *centralis*.
Marsupites, (a new genus).
——— *Milleri*.
Millepora *Gilberti*.
Spongus, (a new genus, formed by Mr. Konig).
——— *labyrinthicus*.
——— *Townsendi*.
Spongia *ramosa*.
Turbinolia *Konigii*.
Ventriculites, (a new genus).
——— *alcyonoides*.
——— *Benettiæ*.
——— *quadrangularis*.
——— *radiatus*.

Echinites.

Cidaris *Konigii*.
Conulus *subrotundus*.
Spatangus *planus*.
——— *rostratus*.

Testaceæ.

Univalves.

Ammonites *biplicatus*.
——— *catinus*.
——— *cinctus*.
——— *complanatus*.
——— *curvatus*.
——— *falcatus*.
——— *Lewesiensis*.
Ammonites *navicularis*.
——— *peramplus*.
——— *Sussexiensis*.
——— *tuberculatus*.
——— *Woollgari*.
Ampullaria *canaliculata*.
Belemnites *Listeri*.
Cirrus *granulatus*.
——— *perspectivus*.
Hamites *alternatus*.
——— *baculoides*.
——— *ellipticus*.
Rostellaria *carinata*.
——— *Parkinsoni*.
Scaphites, *costatus*.
——— *striatus*.
Solarium *canaliculatum*.
Trochus *linearis*.
Turrilites *undulatus*.
Vermicularia *Bognoriensis*.
——— *Sowerbii*.

Bivalves.

Cardium *asperulum*.
——— *decussatum*.
Dianchora *obliqua*.
Fistulana *pyriformis*.
Inoceramus *Brongniarti*.
——— *Cripsii*.
——— *latus*.
——— *striatus*.
——— *tenuis*.
——— *undulatus*.
——— *Websteri*.
Nucula *ovata*.
Pecten *nitida*.
——— *laminosa*.
——— *triplicata*.

Plagiostoma *aspera*.
——— *Brightoniensis*.
——— *Hoperi*.
Terebratula *Martini*.
——— *squamosa*.
——— *striatula*.
——— *subplicata*.
——— *sulcata*.
Venus *Ringmeriensis*.

CRUSTACEA.

Astacus *Leachii*.

FISHES.

Amia? *Lewesiensis*.
Esox *Lewesiensis*.
Muræna *Lewesiensis*.
Salmo *Lewesiensis*.

EXPLANATION OF THE PLATES.

TABLET I.

Geological map of the south-eastern part of Sussex.

TABLET II.

Fig. 1. View from a mill, west of Lewes, exhibiting a profile of the chalk hills to the south of the town, and the situation of the "*Rhies*" in the levels, see page 20.

Fig. 2. View from the eastern brow of Mount Harry, west of Lewes; shewing the general form of the chalk hills in the south-eastern part of Sussex.

Fig. 3. Profile of Cliff Hills, near Lewes; with a section.

TABLET III.

Fig. 1. Plan of the stratification of the county of Sussex.

The Tilgate beds are not introduced, as their position was unknown when this plate was engraved. The "*limestone in clay*" resting on the ferruginous sand, refers to the Framfield limestone; but its situation is incorrect, for subsequent observations have shewn that it *alternates* with the iron-sand *.

Fig. 2. Section from Lewes to the Black Boys. The situation of the limestone near Eason's green, is hypothetical; see the remark on fig. 1.

Fig. 3. Section of the iron sand, and limestone beds, in the parish of Framfield; the strata have not been perforated to a sufficient depth to shew their relative position, p. 32.

TABLET IV.

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Fig. 2. Cliffs east of Brighton, p. 279.

Fig. 3. Fissures in the chalk at Falmer, filled with clay, and the detritus of the breccia of the Plastic clay, p. 151.

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* Limestone, similar to that of Framfield, and Ashburnham, and enclosing the same kind of testaceæ, may be observed alternating with Iron sand, in a quarry near Winchelsea.

TABLET V.

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(The frontispiece).

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2. Bed of oyster shells.
3. Blue clay containing broken bivalves, chiefly of the genera *Cytherea and Cyrenè*.
4. Blue clay, enclosing immense quantities of univalves of the genus *Cerithium*; and sharks' teeth.
5. Reddish brown marl, containing remains of shells and vegetables; see the specimens delineated in Tab. viii.
6. A seam of *surturbrand* or lignite.
7. Blue clay, including crystals of sulphate of lime, &c.
8. Sand.
9. Breccia of green sand and pebbles.
10. Ochraceous clay, containing *hydrate* and *subsulphate* of *Alumine*.
11. The summit of the chalk cliffs.

TABLET VII.

View of the chalk pit at Southerham, near Lewes, shewing the dip of the Lower chalk, p. 140. For this sketch I am indebted to the kindness of Mr. Warren Lee.

TABLET VIII.

Specimens of *red marl* from the Plastic clay beds at Castle Hill, containing the remains and impressions of the foliage of unknown vegetables, allied to the *Platanus orientalis*; and casts of shells of the genera *Cerithium, Cyclas*, and *Unio*, p. 262.

TABLET IX.

Supposed vegetable bodies from the Chalk and Chalk Marl.

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Figs. 2. 12. Linear markings, resembling the foliage of a species of Pinus, p. 157.

Figs. 3. 6. 9. 10. Unknown fossil bodies from the chalk, generally supposed to be the remains of aments or cones, p. 158.

Figs. 4. 5. 7. 8. 11. Supposed aments or cones of a species of Larch, from Hamsey; p. 103.

TABLET X.

Flints of various shapes, deriving their forms from Ventriculites *radiatus*, p. 170.

TABLET XI.

Two specimens of Ventriculites *radiatus*, in which the lower part of the funnel-like cavity is filled with flint; the upper portion being expanded on the chalk, p. 171.

TABLET XII.

Fig. 1. Annular flint formed in a Ventriculite, p. 172.

Fig. 2. A Ventriculite in chalk, exhibiting the external surface, and the ramifications of the radical processes, p. 172.

TABLET XIII.

Fig. 1. A flint deriving its form from Ventriculites *radiatus*, p. 173.

Figs. 2. 3. 5. Chalk specimens of the stirps, or inferior part of Ventriculites *radiatus*, p. 173.

Fig. 4. A Ventriculite with the inferior portion enclosed in flint, and the upper part exposed on the chalk, p. 173.

Fig. 6. Magnified representation of part of the external integument of fig. 2.

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Specimens of Ventriculites *radiatus* expanded on the chalk, p. 173.

Fig. 1. The internal surface studded with numerous perforated papillæ.

Fig. 2. The external surface.

TABLET XV.

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Fig. 3. Ventriculites *Benettiæ*, p. 177.

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Fig. 6. Ventriculites *quadrangularis*, p. 177.

Fig. 7. Spongus *labyrinthicus*, p. 165.

Fig. 8. Siliceous cast of a branched coral, from the centre of a flint, p. 163.

Fig. 9. Siliceous specimen of Spongus *Townsendi*, p. 164.

Fig. 10. Fossil coral, supposed to belong to the genus Millepora; from the chalk marl, p. 106.

Fig. 11. Spongia *ramosa*, p. 162.

TABLET XVI.

Fig. 1. A Belemnite from the chalk at Brighton, p. 201.

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Fig. 6. Marsupites *Milleri*, shewing the pectoral plates in situ, p. 183.

Fig. 7. The semilunar depression on the upper margin of the scapula in M. *Milleri*.

Fig. 8. The outer surface of the clavicle of M. *Milleri*.

Fig. 9. Clavicle and humerus of M. *Milleri*.

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Fig. 11. A group of crystals of sulphuret of iron, from the Lower chalk, near Lewes, p. 140.

Figs. 13, 14. Detached plates of Marsupites *Milleri*, p. 185.

Fig. 15. Marsupites *Milleri*, p. 184.

Fig. 16. Singular form of sulphuret of iron, from the chalk at Steyning, p. 153.

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Fig. 20. Vertical section of the same.

Fig. 21. Transverse section of the same.

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Fig. 2. Siliceous cast of Cidaris *corollaris*, p. 190.

Fig. 3. Cerithium *melanoides*, from the Plastic clay, p. 263.

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Fig. 17. Front view of Spatangus *rostratus*.

Fig. 18. The base of Conulus *subrotundus*.

Fig. 19. ——— *albogalerus*, var. *acuta*.

Fig. 20. The base of fig. 8.

Fig. 21. The base of Spatangus *planus*.

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Fig. 17. Trochus *linearis*, p. 110.

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TABLET XIX.

The whole of the fossils represented in this plate, with the exception of figs. 1, 2, 3, and 34, are from the Blue chalk marl, near Lewes.

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Fig. 23. Variety of Belemnites *Listeri*, p. 88.
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Fig. 33. Cast of a species of Arca? or Nucula?
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TABLET XX.

Fig. 1. Nautilus *elegans*, from the Grey chalk marl at Middleham, p. 112.
Fig. 2. Ammonites *Sussexiensis*, from Hamsey, p. 114.

TABLET XXI.

Nautili, and Ammonites, from the chalk, and chalk marl, near Lewes.

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Figs. 2, 5, 7. Varieties of Ammonites *varians*, p. 115.
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Fig. 9. Costated variety of Ammonites *Mantelli*, p. 113.
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TABLET XXII.

Ammonites, and Scaphites, from the chalk and chalk marl, near Lewes.

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☞ It was the intention of the Author to have subjoined a systematical catalogue of the fossils described in this volume, with copious references to other works, and a list of synonymes; but he has been compelled to abandon the design, having already exceeded the limits assigned him by his publisher.

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The Map is to be considered as Tab. I.

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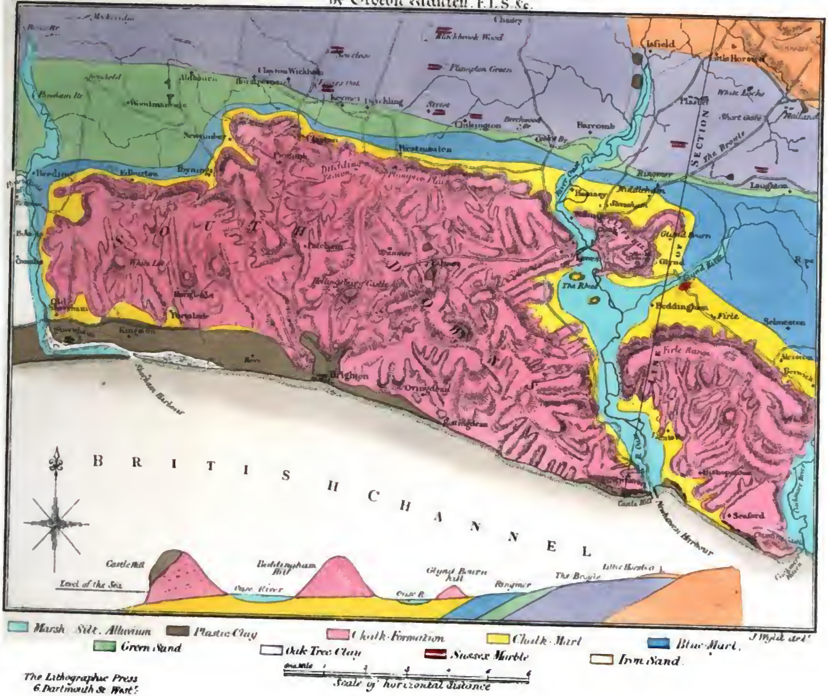

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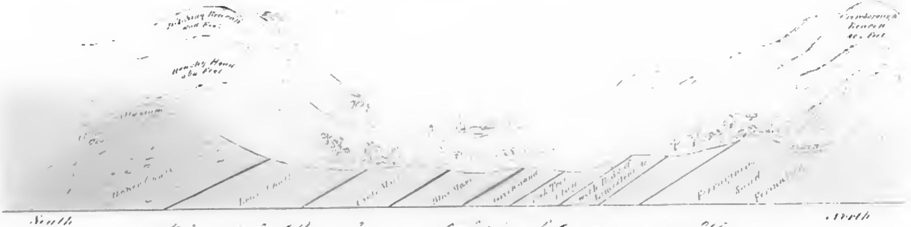

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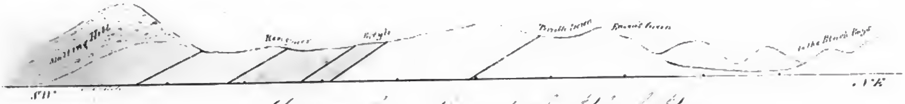

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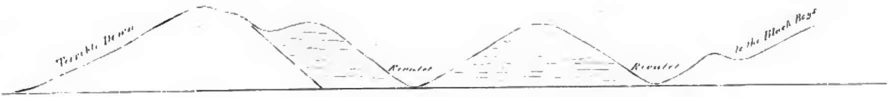

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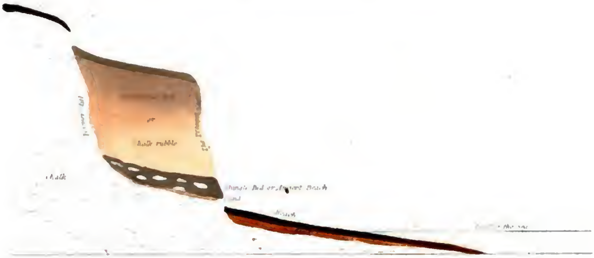
Vertical Section of the Cliff at Brighton



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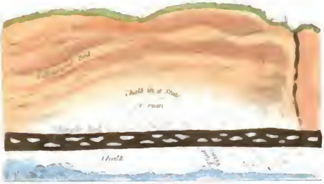
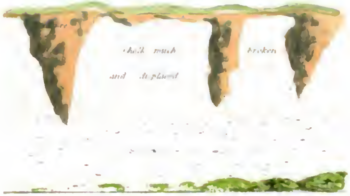
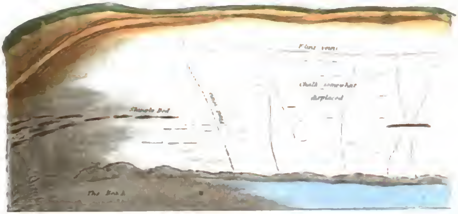
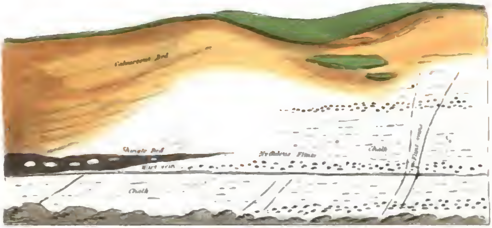


Fissures in the Chalk, near Falmer





Strata between Brighton and Rottingdean



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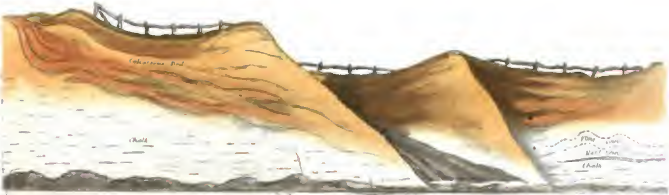

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The Landing Place at Rottingdean

PLATE I.

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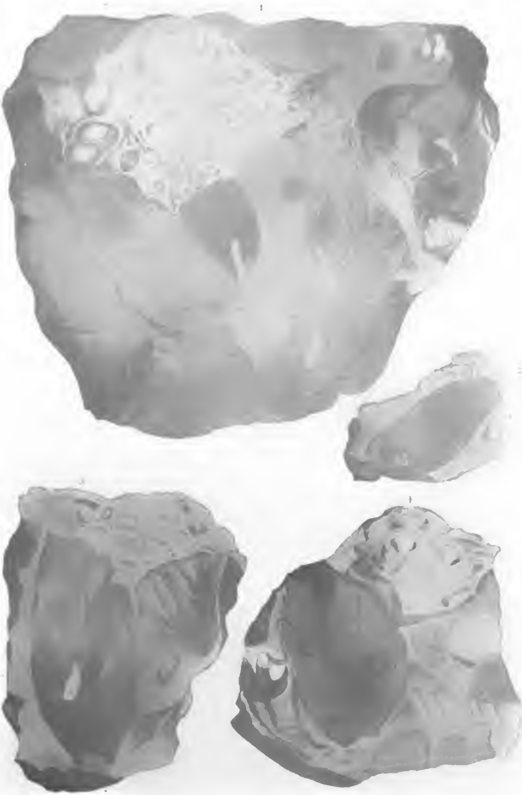

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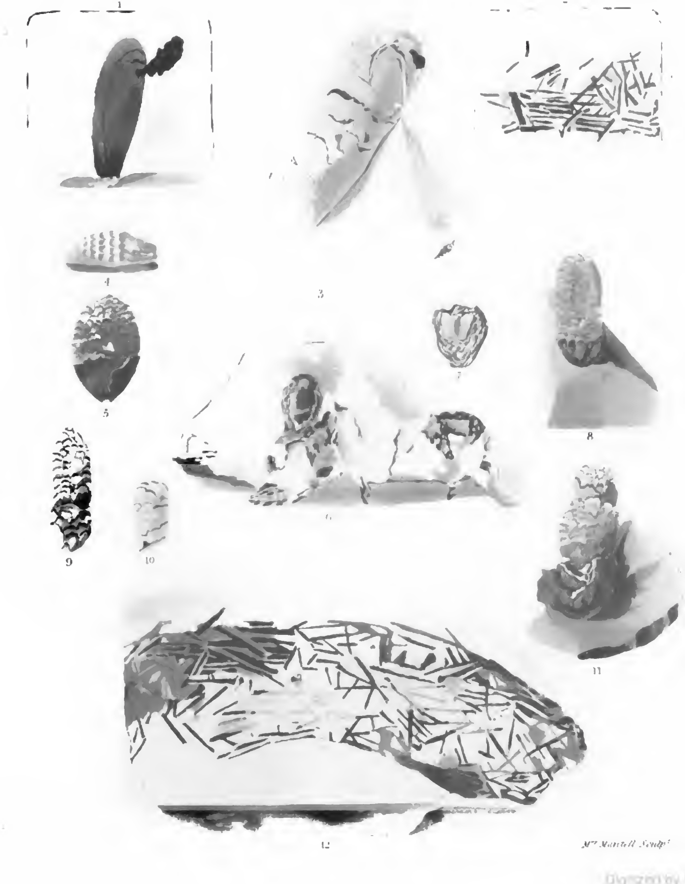

Mrs Mantell Sculpt

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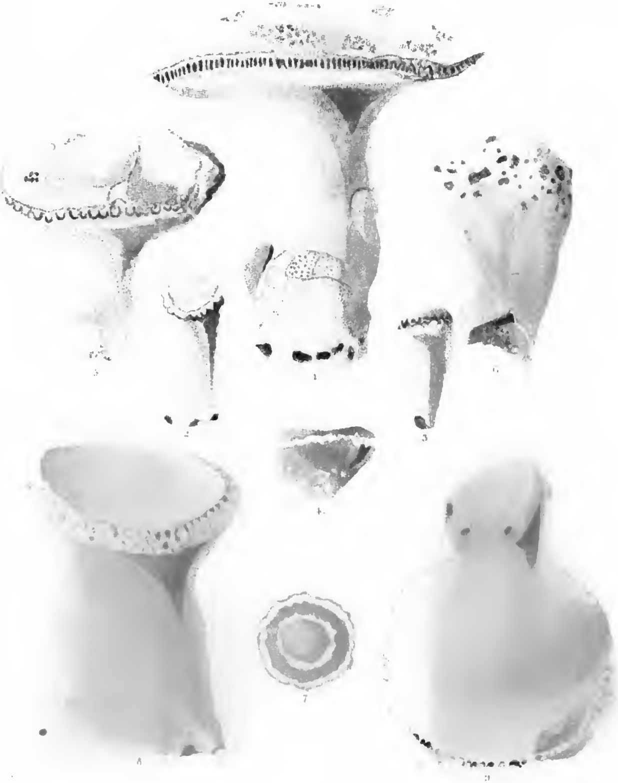

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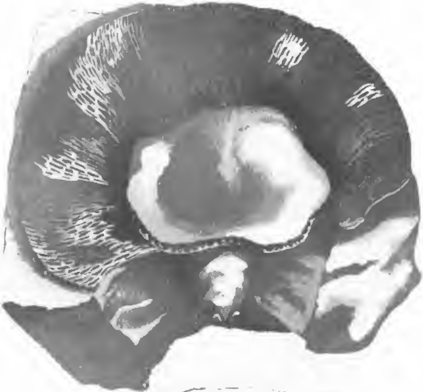

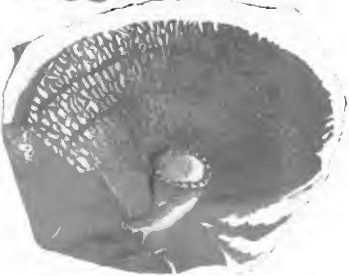

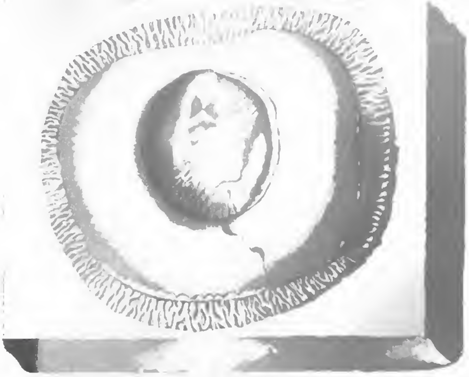

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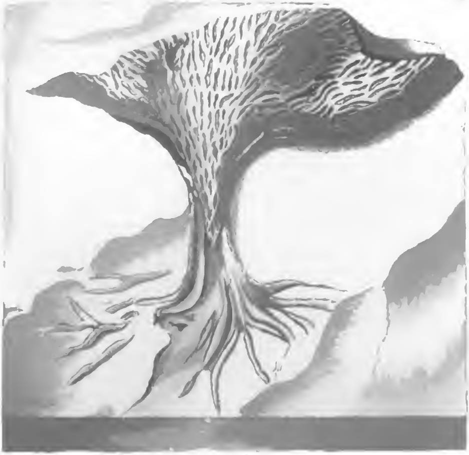

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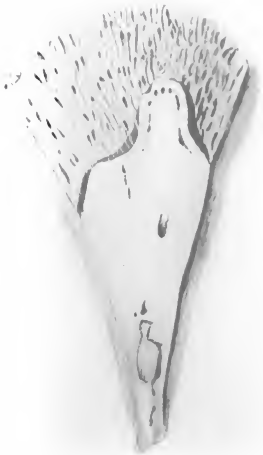

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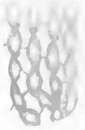

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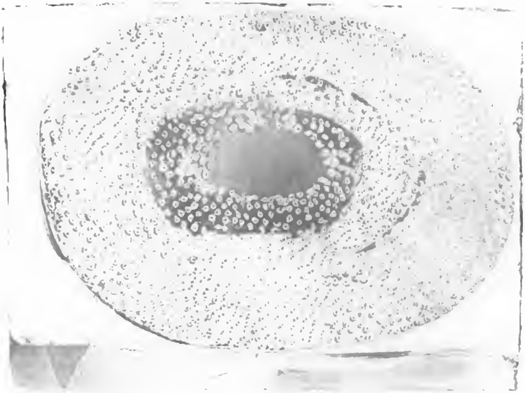

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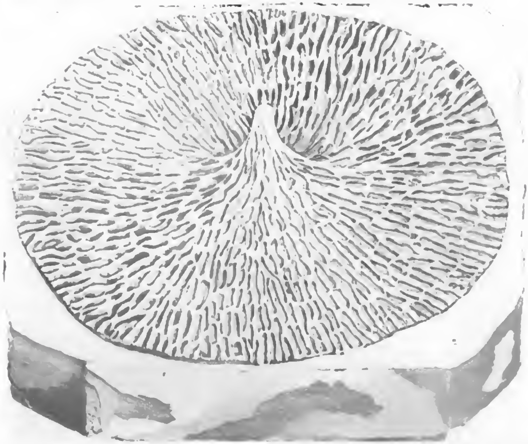

Mary Ann Mantell Sc.

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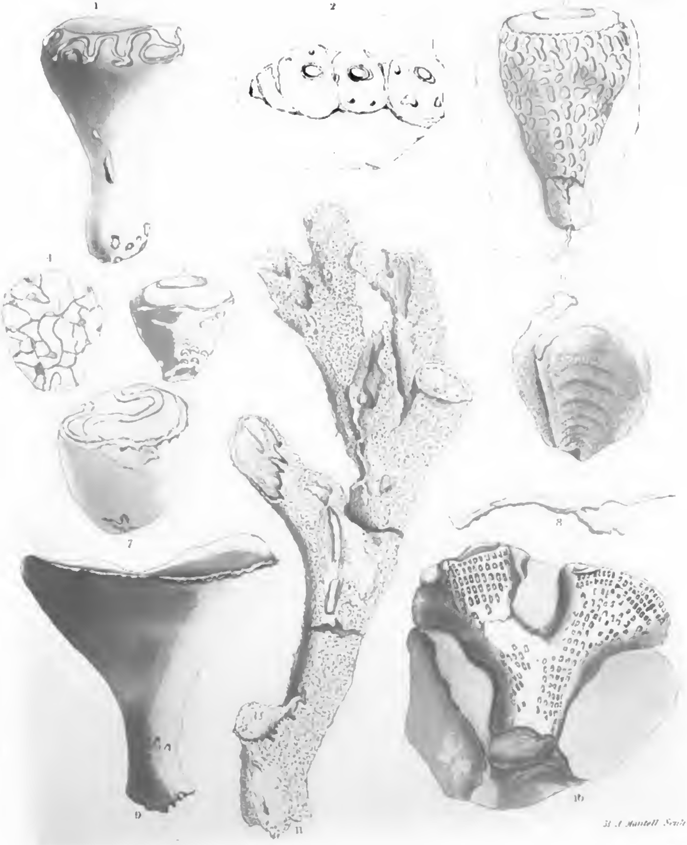

M. A. Mantell Sculpt.

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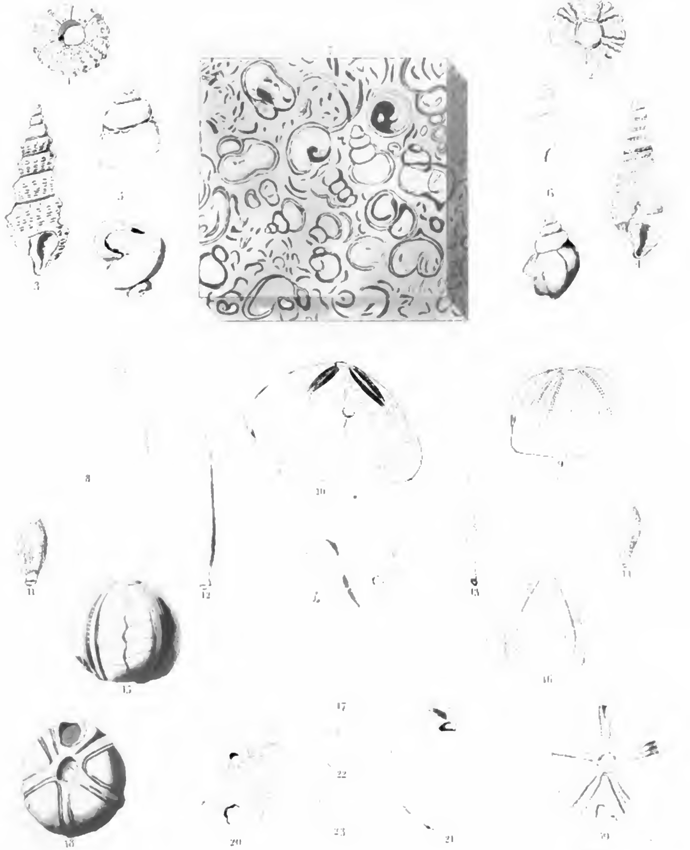

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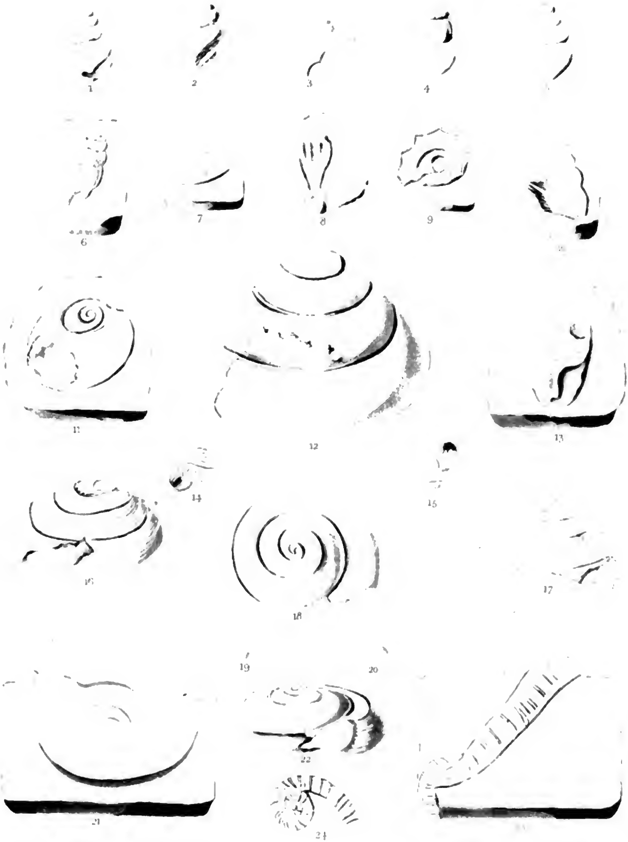

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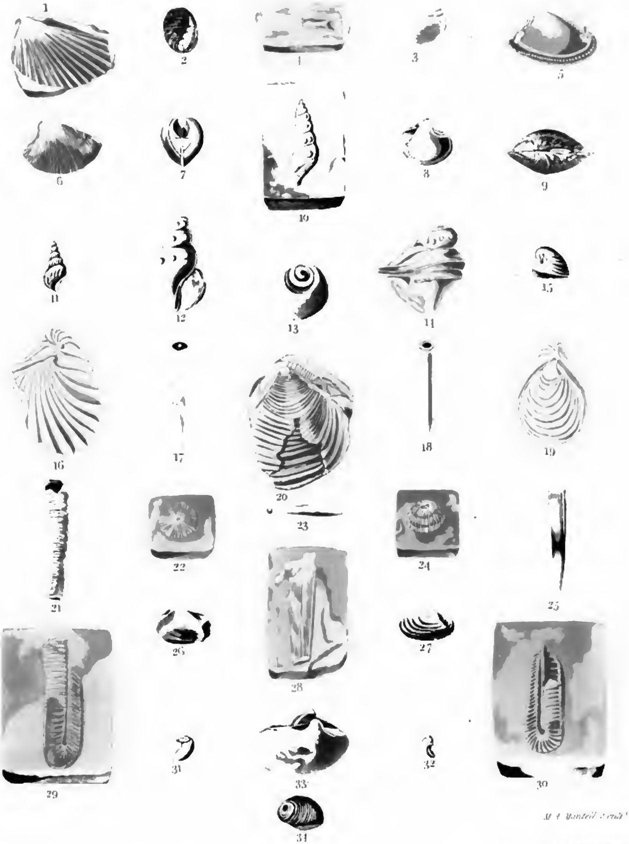

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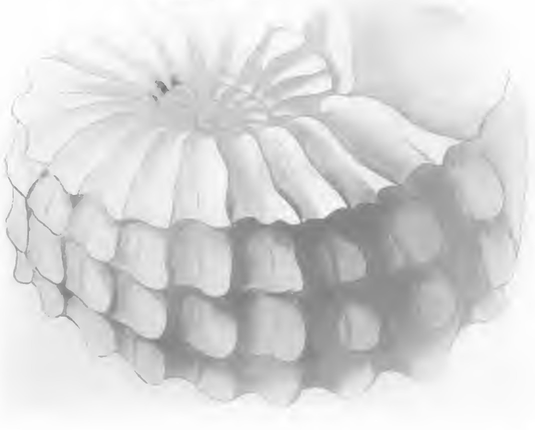

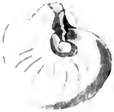
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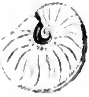
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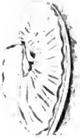
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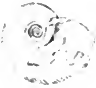
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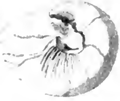
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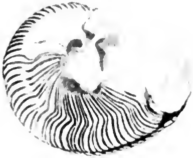
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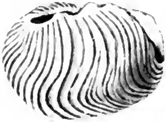
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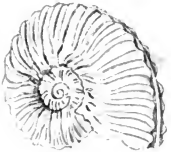
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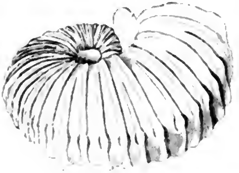
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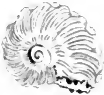
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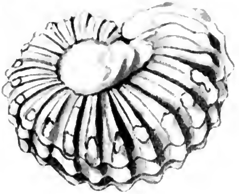
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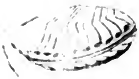
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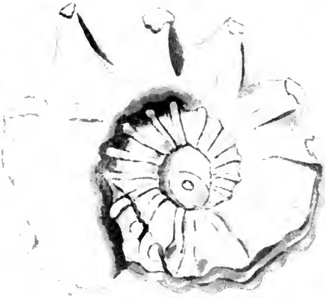
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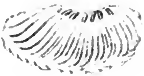
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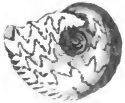
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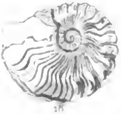
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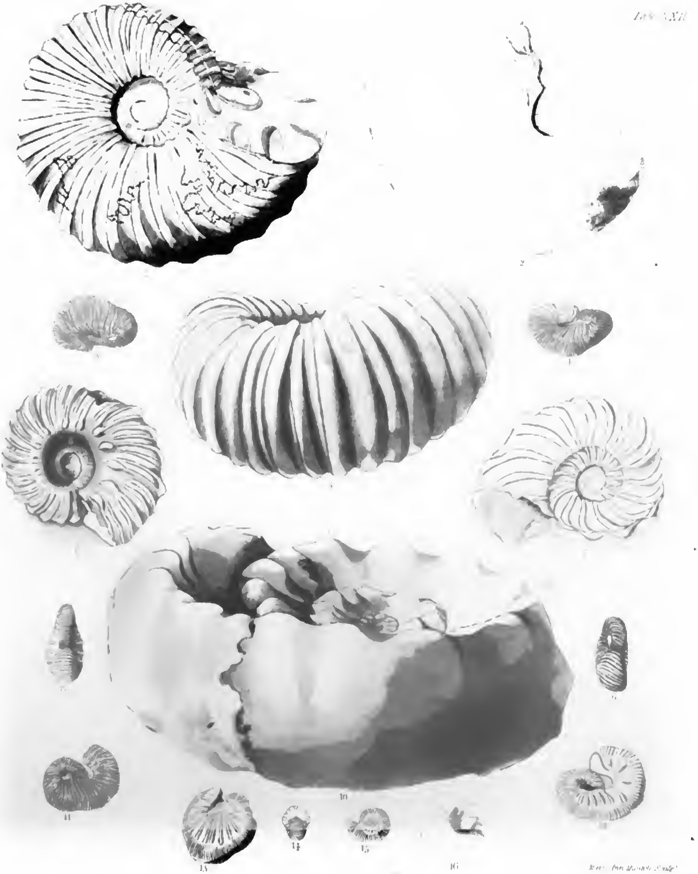
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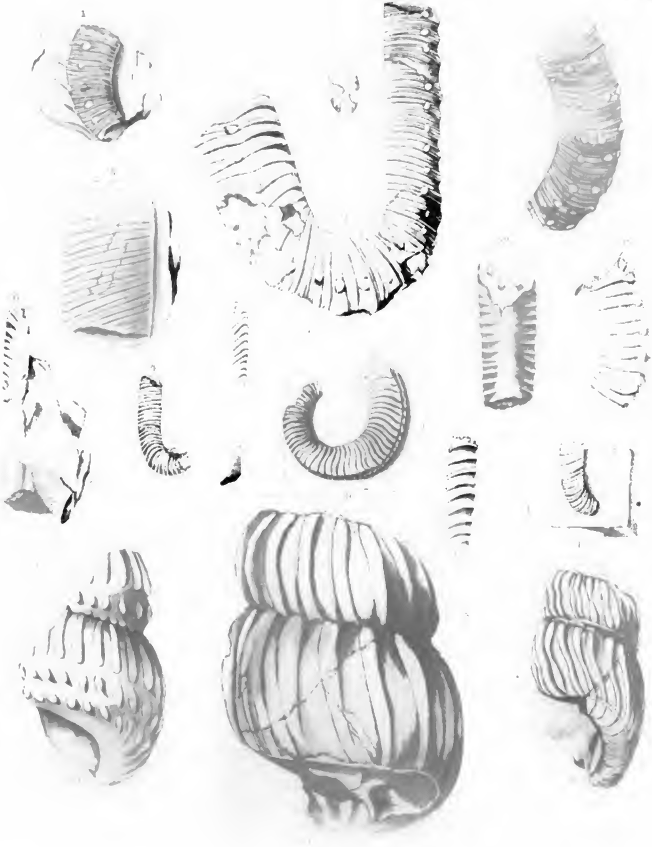

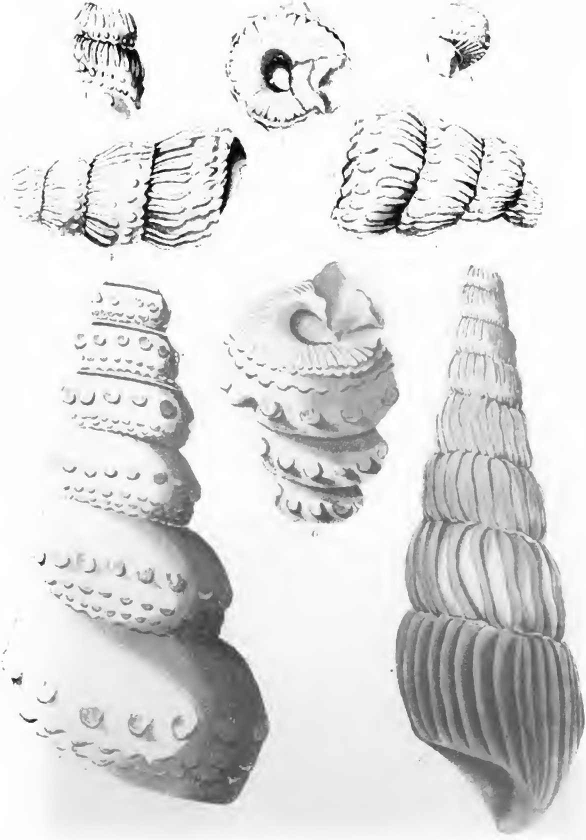

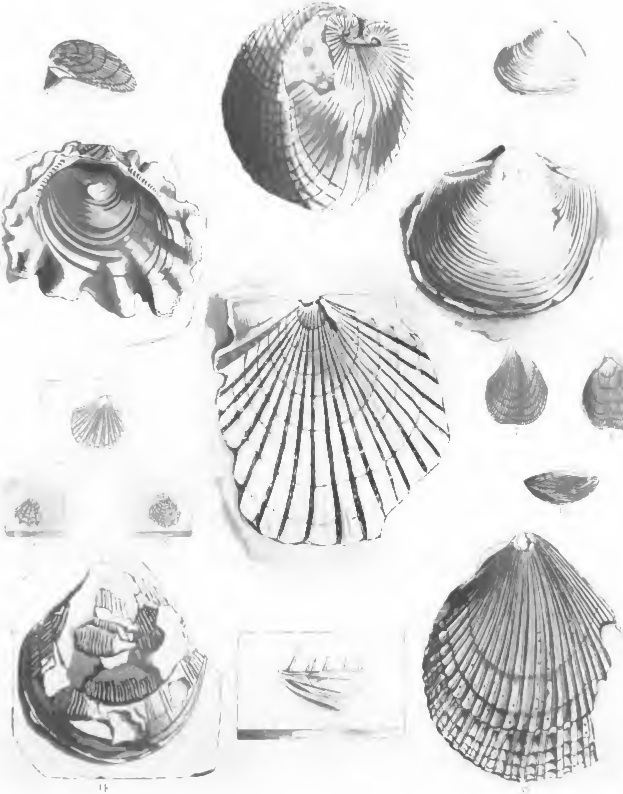

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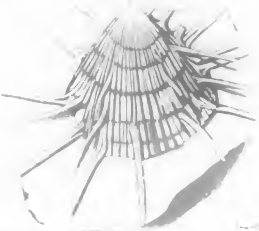

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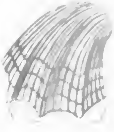

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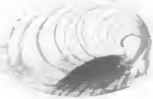

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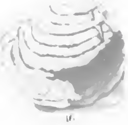

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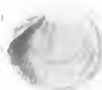

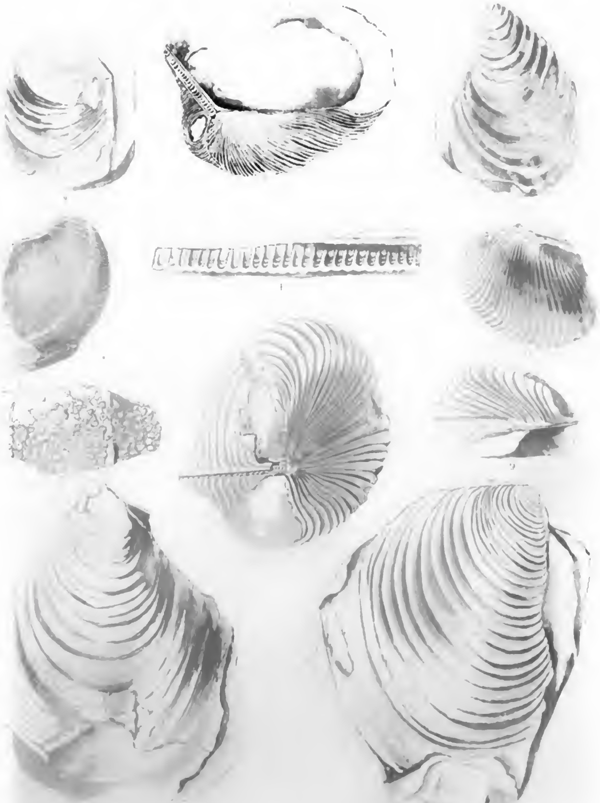

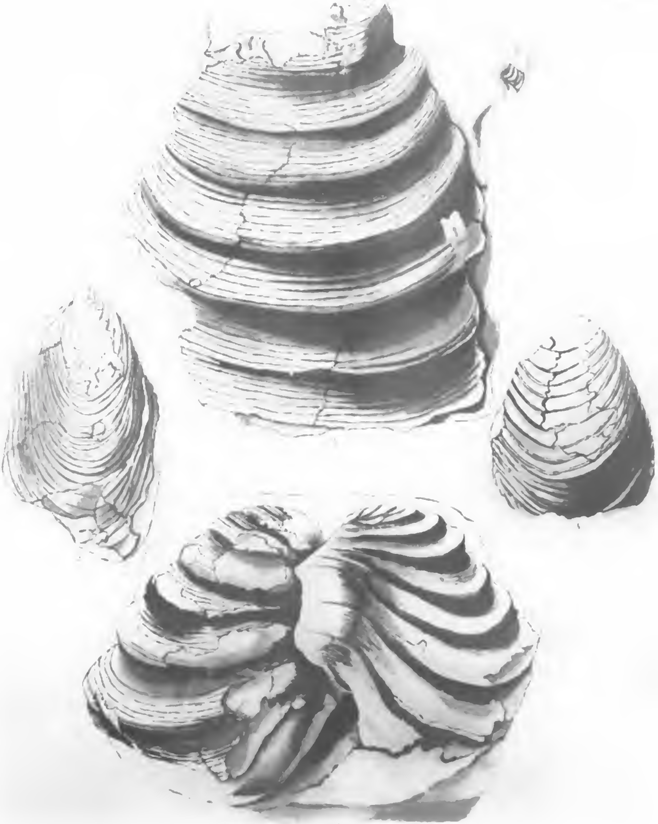

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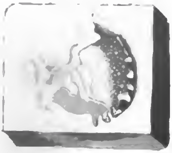

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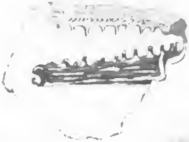

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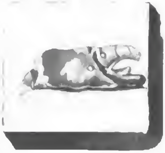

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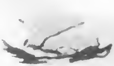

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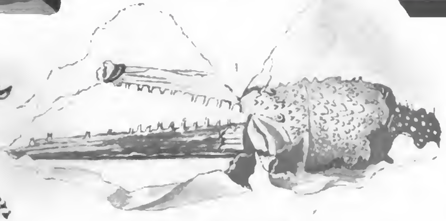

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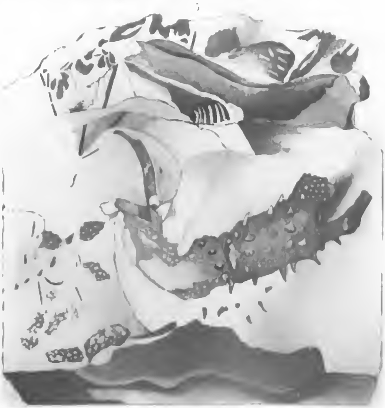

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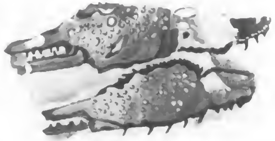

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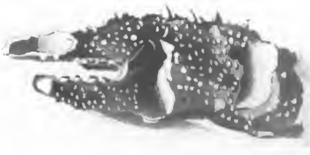

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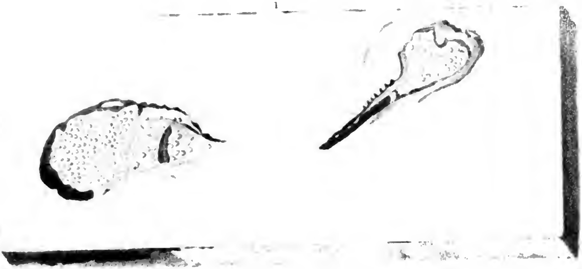

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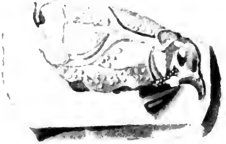

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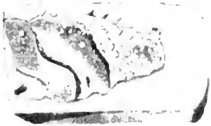

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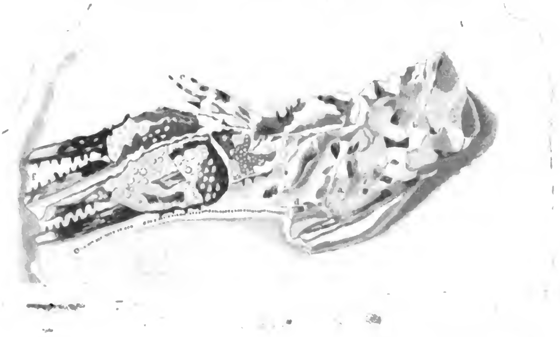

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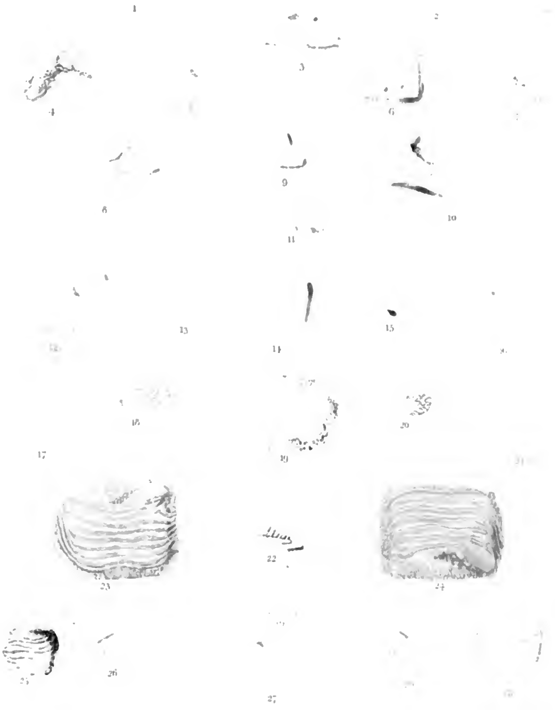
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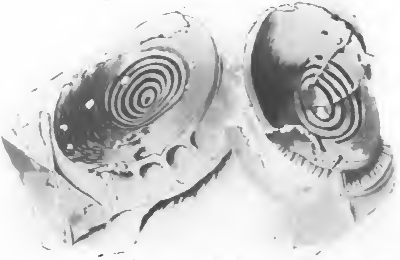

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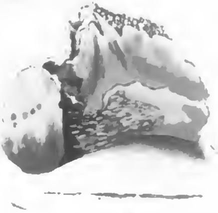

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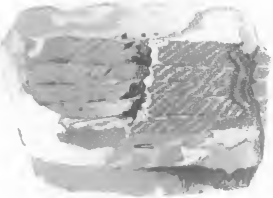

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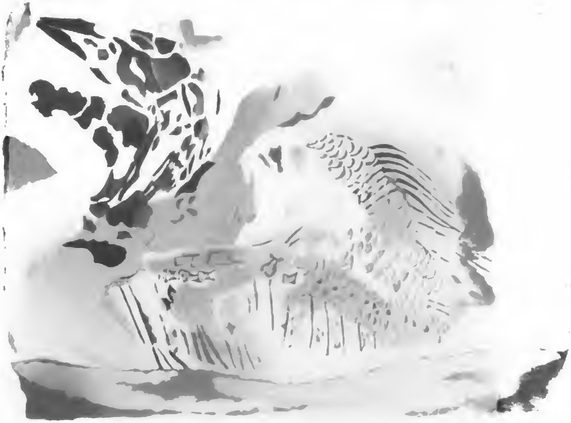
Mary Ann Mantell del.



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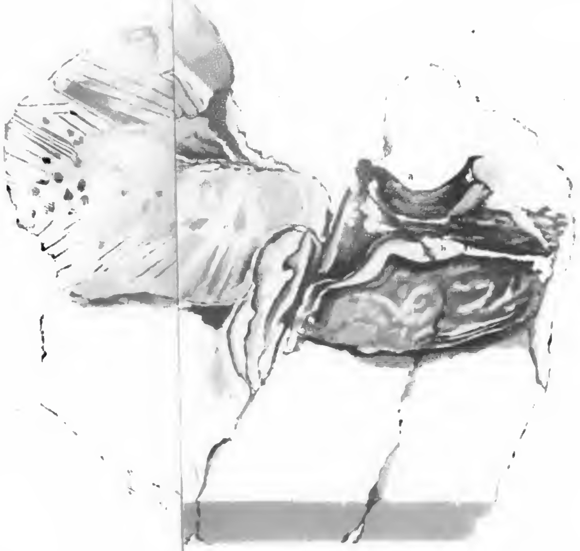
Tab XXXVIII



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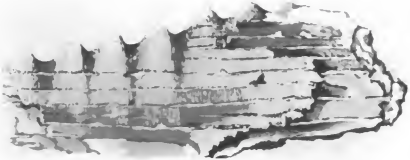
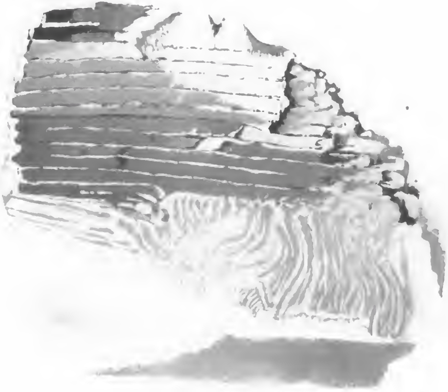
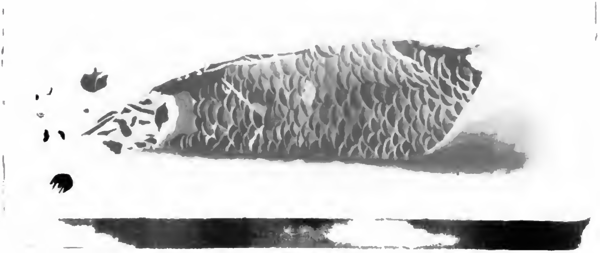
Tab. XXI







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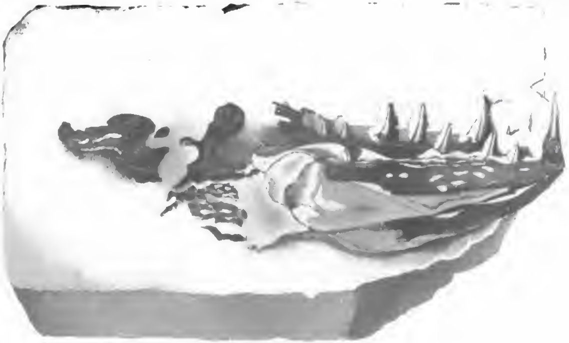

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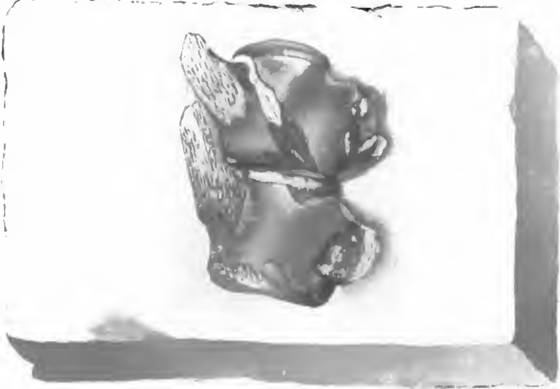

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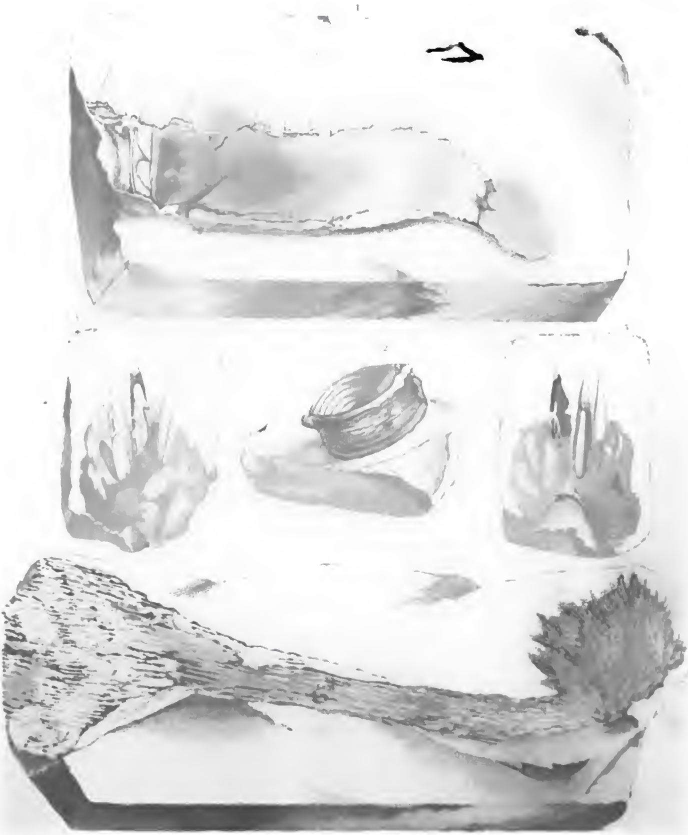
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